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Archaeological, Geophysical, and Remote Sensing Investigations of the 1910 Wright Brothers' Hangar, Wright-Patterson Air Force Base, Ohio

by
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In 1990 and 1994, archaeologists from the Cultural Resources Research Center, U.S. Army Construction Engineering Research Laboratories (USACERL) investigated the Wright Company School of Aviation 1910 Hangar component of the Huffman Prairie Flying Field Site at Wright-Patterson Air Force Base, Ohio. The USACERL archaeological investigations were integrated with geophysical studies conducted by the U. S. Army Corps of Engineers Waterways Experiment Station (CEWES), and airborne remote sensing studies conducted by the Earth Observation Research Office of the Science and Technology Laboratory at the John C. Stennis Space Center, NASA. Funded by the Department of Defense Legacy Resource Management Program, the investigations were designed to provide information needed for site management by Wright-Patterson Air Force Base and the Dayton Aviation Heritage National Historical Park of the National Park Service. Site management goals included site preservation and public education.

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In 1990 and 1994, archaeologists from the Cultural Resources Research Center, U.S. Army Construction Engineering Research Laboratories (USACERL) investigated the Wright Company School of Aviation 1910 Hangar component of the Huffman Prairie Flying Field Site at Wright-Patterson Air Force Base, Ohio. The USACERL archaeological investigations were integrated with geophysical studies conducted by the U. S. Army Corps of Engineers Waterways Experiment Station (CEWES), and airborne remote sensing studies conducted by the Earth Observation Research Office of the Science and Technology Laboratory at the John C. Stennis Space Center, NASA. Funded by the Department of Defense Legacy Resource Management Program, the investigations were designed to provide information needed for site management by Wright-Patterson Air Force Base and the Dayton Aviation Heritage National Historical Park of the National Park Service. Site management goals included site preservation and public education.

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Prepared For

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5490 Pearson Road
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By

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Cultural Resources Research Center
U. S. Army Construction Engineering Research Laboratories
Champaign, Illinois

June 1998

FOREWORD

This study was conducted for the Legacy Resource Management Program (DoD Project No. 92-445, "1910 Hangar Excavations at the Huffman Prairie Flying Field"). The technical monitor for this project was Dr. Jan Ferguson, Historic Preservation Program Manager, Resource Protection Branch, Office of Environmental Management, Wright-Patterson Air Force Base, Ohio.

The work was performed by the Cultural Resources Research Center, Planning and Mission Impact Division (LL-P), Land Management Laboratory, U. S. Army Construction Engineering Research Laboratories, Champaign, Illinois. The USACERL Principal Investigator was initially Keith Landreth. Following Mr. Landreth's departure from USACERL, David Babson assumed primary responsibility for the project. Dr. Michael L. Hargrave coordinated completion of the project following Mr. Babson's departure from USACERL. Dr. Harold E. Balbach is Chief, CECER-LL-P, and Dr. John T. Bandy is Operations Chief, CECER-LL. COL James A. Walter is Commander, and Dr. Michael J. O'Connor is Director of USACERL.

The Legacy Resource Management program was established in 1991 by the U. S. Congress to provide Department of Defense (DoD) with an opportunity to enhance the management of stewardship resources on over 25 million acres of land under DoD jurisdiction.

Legacy allows DoD to determine how to better integrate the conservation of irreplaceable biological, cultural, and geophysical resources with the dynamic requirements of military missions. To achieve this goal, DoD gives high priority to investigating, protecting, and restoring biological, cultural, and geophysical resources in a comprehensive, cost-effective manner, in partnership with Federal, State, and local agencies, and private groups.

Legacy activities help ensure that DoD personnel better understand the need for protection and conservation of natural and cultural resources, and that the management of these resources is fully integrated with, and supports, DoD mission activities and the public interest. Through the combined efforts of the DoD components, Legacy seeks to achieve its legislative purposes with cooperation, industry, and creativity, to make DoD the federal environmental leader. For further information concerning the Legacy Program you can contact the Conservation Division, Environmental Programs Office, Chief of Engineers, 2600 Army Pentagon, Washington, D. C., 20310-2600.

MANAGEMENT SUMMARY

In 1990 and 1994, archaeologists from the Cultural Resources Research Center, U.S. Army Construction Engineering Research Laboratories (USACERL) investigated the Wright Company School of Aviation 1910 Hangar component of the Huffman Prairie Flying Field Site at Wright-Patterson Air Force Base, Ohio. The USACERL archaeological investigations were integrated with geophysical studies conducted by the U. S. Army Corps of Engineers Waterways Experiment Station (CEWES), and airborne remote sensing studies conducted by the Earth Observation Research Office of the Science and Technology Laboratory at the John C. Stennis Space Center, NASA. Funded by the Department of Defense Legacy Resource Management Program (Project # 92-445), the investigations were designed to provide information needed for site management by Wright-Patterson Air Force Base and the Dayton Aviation Heritage National Historical Park of the National Park Service. Site management goals included site preservation and public education.

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We thank Dr. Jan Ferguson, Base Historic Preservation Officer, and David P. Duell, Chief, Resource Protection Branch, Office of Environmental Management, WPAFB, for their assistance and patience in the completion of this monograph. Ronald Statzer, Chief of the Grounds Maintenance Unit of Civil Engineering, contributed to the project by providing personnel and heavy equipment during the 1994 excavations. The 1994 research design was reviewed by staff at the base and the Ohio Historic Preservation Office. We also extend our appreciation to William Gibson, Superintendent, and Anne Deines, Park Historian, of the Dayton Aviation Heritage National Historical Park, National Park Service, Department of the Interior.

The 1990 USACERL field crew, led by Keith Landreth, included Richard Edging, Evan Engwall, and James Bowman. Mr. Landreth consulted with the authors during preparation of this report, providing valuable information about the 1990 program of investigations. The 1990 site map was prepared by Rita Moots of Eastern New Mexico University. Artifacts from the 1990 excavations were analyzed with the assistance of Jerry Moore, Jennifer Takas, and Brian Lesley, Midwestern Archaeological Research Center, Illinois State University.

The geophysical investigations discussed in this report were undertaken under the direction of Dwain K. Butler, Waterways Experiment Station, U.S. Army Corps of Engineers. Thomas L. Sever, Earth Observation Research Office, Science and Technology Laboratory, Stennis Space Center, NASA directed the airborne remote sensing study. We thank Dr. Butler and Dr. Sever for their co-operation with the archaeological investigations, and for their extensive consultation during the 1994 program of investigations.

1994 USACERL investigations were conducted by Larry Abbott, David Babson, Robert Chenier, Michael Hargrave, John Isaacson, Jun Kinoshita, Chevon Kotahri, Roy McCullough, and James Zeidler. Larry Abbott provided geomorphological analysis of soils from the 1910 Hangar locus. Maps and illustrations were prepared by Jun Kinoshita, Dan Haag, and Michael Halton. Suzanna Doggett made final revisions to the AutoCad maps. Diane Timlin produced final copies of the GIS figures. Artifacts were photographed by David Babson. The 1994 artifact analysis was conducted by David Babson with assistance from Amy Uzarski. James Zeidler edited Appendix A.

Chapter 1
INTRODUCTION

Introduction

From 1990 through 1994, the Cultural Resources Research Center at USACERL (U. S. Army Construction Engineering Research Laboratories) conducted a multidisciplinary investigation of the Huffman Prairie Flying Field Site at Wright-Patterson Air Force Base (WPAFB), Ohio. This work was undertaken at the request of the WPAFB Resource Protection Branch, Office of Environmental Management and funded by WPAFB (1990) and the Department of Defense's Legacy Resource Management Program (Legacy Project # 92-445, "1910 Hangar Excavations at the Huffman Prairie Flying Field"). These investigations are part of a continuing effort by WPAFB to manage the Huffman Prairie Flying Field Site and to develop it as a resource for public information and education. This development reflects the site's great importance to the early history of aviation. Huffman Prairie Flying Field is the place where, in 1904 and 1905, Wilbur and Orville Wright developed a practical and marketable airplane from the prototype they had flown successfully at Kitty Hawk, North Carolina in 1903. At Huffman Prairie the Wright brothers also operated a flight school (the Wright Company School of Aviation) and an aircraft testing facility from 1910 to 1916, and a support base for exhibition flying in 1910 and 1911. Future plans for the site include displays interpreting the site's history, to be in place for the centennial of powered, heavier-than-air flight in 2003.

Objectives

The present report details efforts by USACERL to locate and assess the nature and integrity of archaeological remains of the 1910 Hangar. Major goals of this project are to support compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, for any future reconstruction project, and to gather archaeological, architectural, and historical information to enhance interpretation of this location.

Background

Efforts to locate the 1910 Hangar commenced in 1990 with a pedestrian survey and soil phosphate testing (Landreth n.d.). Later that year, USACERL conducted a rather extensive program of excavation intended to locate foundations or drip lines associated with the hangar. Details of this effort are presented in Chapters 6 and 7 of this report.

Results of the 1990 excavations suggested that locating archaeological remains of the 1910 Hangar would require a change in strategy. Accordingly, USACERL contracted with the Geotechnical Laboratory of the Waterways Experimental Station, U.S. Army Corps of Engineers (CEWES), and the Science and Technology Laboratory of the National Aeronautics and Space Administration (NASA) to perform geophysical and remote sensing studies (respectively). These studies were intended to identify the precise location of the 1910 Hangar without resorting to more

extensive excavations. Results are discussed in Chapter 4, Appendix A, and the CEWES report (Butler, et al. 1994).

In October of 1994, archaeologists from USACERL returned to the Huffman Prairie Flying Field site to ground-truth (i.e., investigate through excavation) the anomalies discovered by the CEWES geophysical survey (Butler, et al. 1994). These investigations located subsurface features (an in situ post, a posthole, and a possible posthole) associated with the 1910 Hangar structure. Details of the 1994 excavations are presented in Chapters 6 and 7.

1910 Hangar Locus

The Huffman Prairie Flying Field is one of four locations included in the Dayton Aviation Heritage National Historical Park. Overall management of the park is the function of the National Park Service, although management of the Huffman Prairie Flying Field remains the responsibility of the Department of Defense and WPAFB. The Huffman Prairie Flying Field site is a National Historic Landmark, due to its association with the Wright Brothers, the Wright Aeronautical Company, and their development of the airplane between 1904 and 1916. The site is located in the northern half of Section 1, Township 2, Range 8 (Figure 1). The site limits are marked by seven boundary pylons erected by WPAFB in 1990 (Landreth 1991). These pylons encompass the flying courses used at the Huffman Prairie Flying Field in 1904-05 and 1910-16, as reported by Orville Wright in 1941 (Walker and Wickam 1986:336). The marker pylons demarcate the boundaries of Huffman Prairie Flying Field as a historical site. Archaeological deposits within the site are relatively localized. The 1910 Hangar is located in the northeastern part of the flying field, northwest of the 1941 concrete monument, near the northern boundary of the site (Figure 2). This boundary corresponds to the south side of the old course of Simms Road, which once continued southeast of its present terminus at Marl Road (the old Dayton and Springfield Turnpike). Simms road was an important landscape feature during the use of Huffman Prairie Flying Field by the Wright brothers and by the Wright Aeronautical Company between 1904 and 1916.

As a part of the Huffman Prairie Flying Field site, the 1910 Hangar is best regarded as an archaeological component or locus. Other archaeological components of the site include the two small hangars used by the Wright brothers in 1904 and 1905. The 1905 Hangar has been located but the position of the 1904 Hangar has not. Relationships between these site components will be discussed at greater length in the next chapter.

The Huffman Prairie Flying Field site and the 1910 Hangar locus share associations with other archaeological and historical sites in the immediate area. Most importantly, the Huffman Farmstead is adjacent to the Huffman Prairie Flying Field. This farm belonged to Torrence Huffman, the Dayton banker who gave the Wrights permission to test their aircraft at Huffman Prairie in 1904 and 1905. From 1910 to 1916, while the Wright Aeronautical Company rented the flying field, some pilot trainees boarded at this farm. Other sites and landscape features (roads, an interurban right-of-way and Simms Station, a stop on this interurban) in the immediate vicinity are also associated with the Huffman Prairie Flying Field, and they provide the local context of this important historical site.

The 1910 Hangar locus underwent site formation processes which are not shared by the rest of the site. These processes (discussed in the next chapter) involve discrete periods of construction, use, alteration and destruction of the hangar building, any and all of which almost certainly are manifested

in the archaeological record of the hangar locus. These periods are: (1) Construction of the hangar in 1910. (2) Use of the hangar by the Wright Aeronautical Company to store aircraft between 1910 and 1916, with some use as late as 1918. The area around the hangar, also part of the 1910 Hangar locus, was probably used to service and repair aircraft and for pre-flight training of pilots during this period. (3) Abandonment of the hangar between 1916/18 and 1924. (4) Refurbishment of the hangar in 1924 for use in the Dayton International Air Races in October of that year. (5) Use of the hangar to exhibit the Wright Brother's 1903 Flyer *Kitty Hawk* during the International Air Races. (6) Abandonment of the hangar between 1924 and the early 1940s. (7) Demolition of the dilapidated hangar structure in the early 1940s, in association with the World War II mobilization.

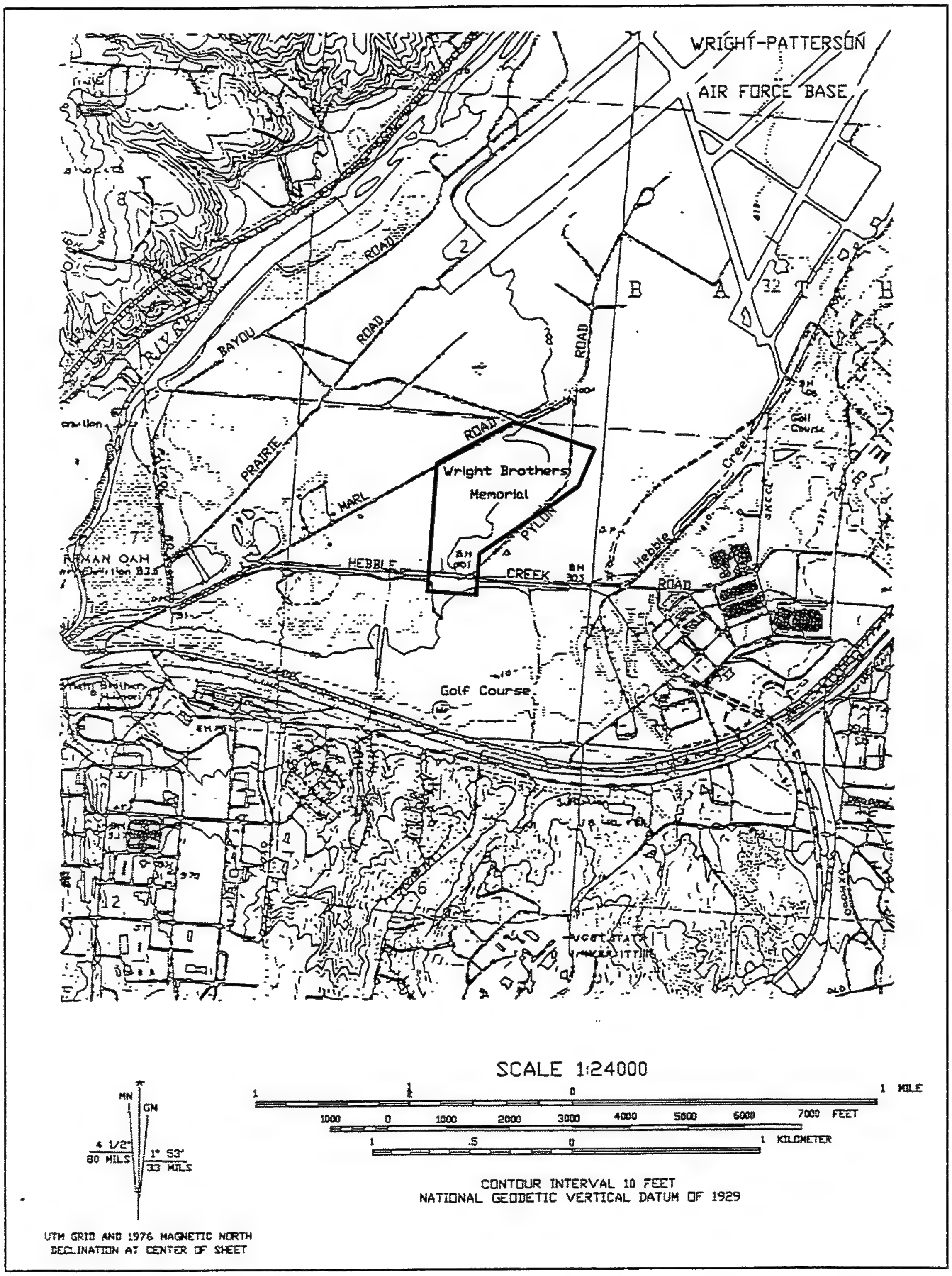

Figure 1. Location of Huffman Prairie Flying Field on 7.5' U.S.G.S. Map of Fairborn, OH

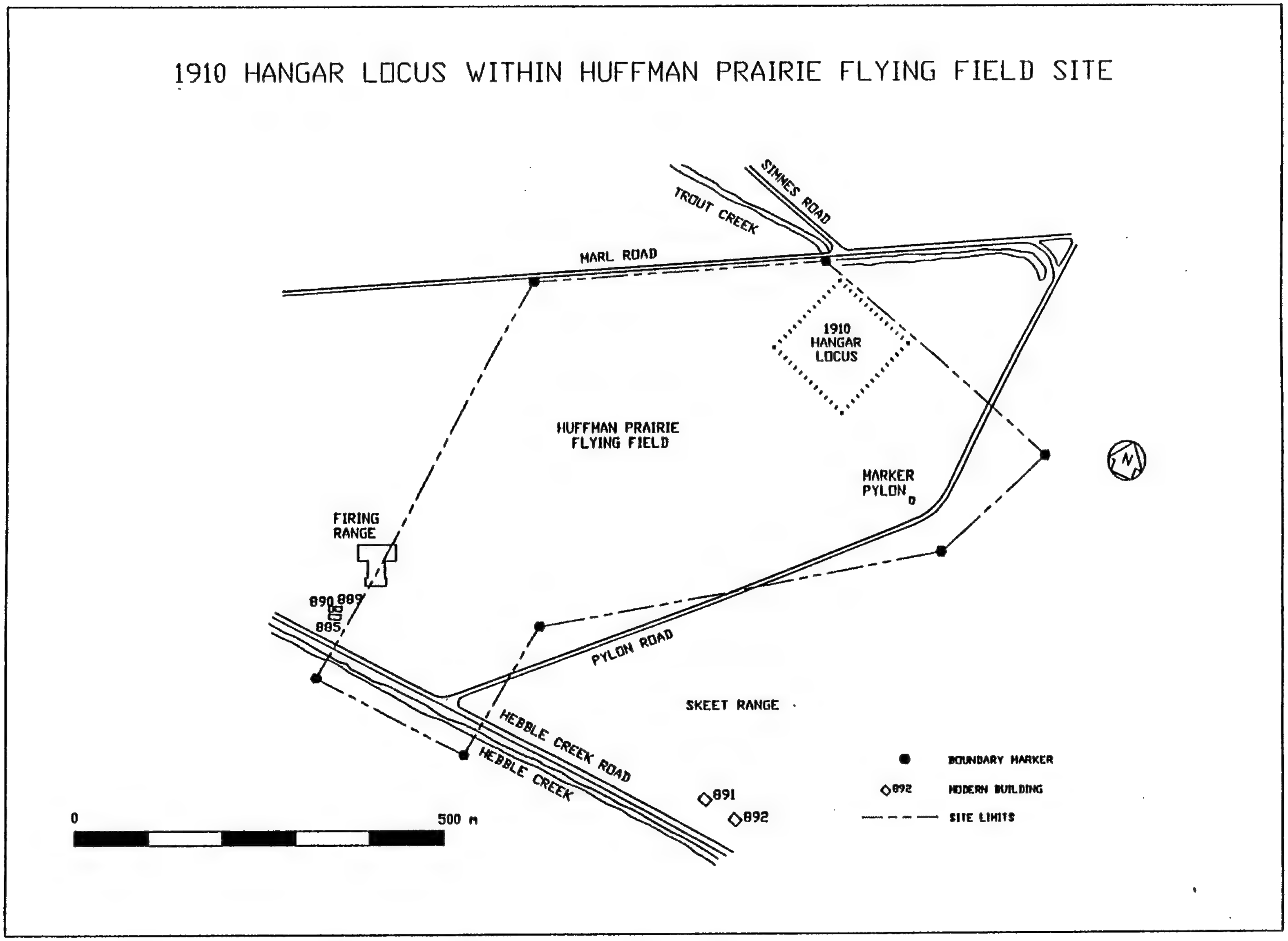

Figure 2. 1910 Hangar Locus Within the Huffman Prairie Flying Field Site

Chapter 2
HISTORY OF THE HUFFMAN PRAIRIE FLYING FIELD

The Wright Brothers and Huffman Prairie

The Huffman Prairie Flying Field site derives its historical importance from its use by Wilbur and Orville Wright during two critical phases of their invention and development of the airplane, from 1904 to 1905 and from 1910 to 1916. The Wright brothers first expressed an interest in aeronautics in the mid-1890s, following the death of Otto Lillenthal and other set-backs to early aviation (Crouch 1989:140-145). In 1899, Wilbur Wright wrote to the Smithsonian Institution, stating his intent to undertake a systematic inquiry into the problems of aviation. The Smithsonian responded with several pamphlets and reports (Howard 1987:30-31). Aided by a decade-long correspondence and friendship with Octave Chanute, the world's foremost experimenter in aviation before the Wrights, Wilbur and Orville Wright proceeded to construct a series of gliders. They flew these prototypes first near their home in Dayton, Ohio, and then, from 1900 to 1903, at Kitty Hawk, North Carolina (Jakab 1990:83-114). From their early gliders, the Wrights discovered that figures then accepted for the coefficient of lift (which measures the relationship between wing area, airspeed and drag in a heavier-than-air craft; Jakab 1990:77-78) were greatly in error. A series of wind tunnel experiments conducted in Dayton in 1901 gave the Wrights a much more accurate coefficient of lift (Jakab 1990:115-142). At Kitty Hawk in 1902, the Wright brothers worked out the connection between "wing warping" (aileron control) and rudder position that is basic to three-dimensional (pitch, yaw and roll) control in aircraft (Jakab 1990:170-182). This concept was the basis of the Wrights' patent of 1906 (Howard 1987:149-150, Jakab 1990:174-175, 185), and it remains the fundamental concept of fixed-wing aircraft design to this day (Jakab 1990:175). They were also the first to realize that an airplane propeller is not an aerial version of a ship's propeller, but a rotating wing (Jakab 1990:194-195). All of this information was brought together successfully by Wilbur and Orville Wright when they flew their Flyer at Kitty Hawk on December 17, 1903, becoming the first individuals to research, design, build and fly a heavier-than-air craft.

Recent biographers of the Wright brothers (Crouch 1989, Howard 1987; especially Jakab 1990) have emphasized their superb, natural talents as experimental engineers. Orville and Wilbur Wright were scientists, able to visualize new technologies, integrate new data with existing information, develop new theories, and construct a practical, working machine from this research. This process of development (Jakab 1990:1-17) could not proceed without repeated, practical tests. The historical significance of Huffman Prairie arises from this process of experimentation and testing. After their first success at Kitty Hawk in 1903, the Wrights returned to Huffman Prairie to develop an airplane that would be controllable under all conditions, usable by people of more ordinary talents, and marketable to both governments and the general public (Crouch 1989:274-286). While no single reason exists for their initial choice of Huffman Prairie as an experimental field (Crouch 1989:279), it was far more convenient to their home and bicycle repair business in Dayton than was North Carolina, and it did not have the unusually-favorable wind conditions of Kitty Hawk. The Wright brothers located their airplane factory in South Dayton, and Huffman Prairie continued to be used as a convenient test site. One of the Wrights' first tasks in launching their airplane production and exhibition company was to train pilots (Howard 1987:352-354). Huffman Prairie was a place the

Wrights knew well, especially from the air, and this undoubtedly aided them in the task of training inexperienced pilots.

The Huffman Prairie Flying Field Site is located in the southern part of Area A of WPAFB, south of the main runway (see Figure 1). This area has not been disturbed by construction or cultivation since it was acquired as part of the Miami Conservancy District between 1915 and 1919, although it may have suffered some disturbance from military training activities since World War II (Landreth 1990). The Miami Conservancy District (1915) controlled the Huffman Prairie area for only a short while before it was rented and later purchased by the U.S. Army. Army control of the site area was occasioned by establishment of institutional ancestors of WPAFB after 1917.

Before 1915, Huffman Prairie was owned by the Huffman family. Historical maps published in 1896 indicate that the Huffman farmstead was located in the extreme northeastern corner of Section 1, Range 8 Township 2 or in the extreme northwestern corner of Range 8 Township 3 Section 31 (Babson 1993; Riddell and Riddell 1896; Wilson et al. 1906). This farmstead may have been the original home of the Huffman family, but by 1904 it was occupied by a tenant farmer (Crouch 1989:279). This site was visited and described during the 1990 Historical Archaeological Site Inventory (Babson 1993).

Torrence Huffman, a Dayton banker (Crouch 1989:279), owned the Huffman Prairie tract in 1896 (Riddell and Riddell 1896). He was a friend of the Wright brothers, and in 1904, they secured permission to use one of his pastures for their aeronautical experiments. The site was near the Simms Station stop on the Dayton and Springfield Interurban line, yet relatively isolated (Crouch 1989:279). Accordingly, Wilbur and Orville Wright made many flights here through 1904 and the spring of 1905, as they perfected subsequent versions of their successful 1903 "Kitty Hawk" flyer (Crouch 1989:279-281, Walker and Wickam 1986:3-5). They erected two small, frame hangars (one in 1904 and a second in 1905) somewhere on Huffman's pasture. The 1905 hangar was located near a concrete pylon erected on the site in 1941. The 1904 hangar was located toward the southern end of the field, but the exact location is not known. These hangars were open at both ends and fitted with large, "flap" doors that could be raised like awnings. They were similar to a series of structures the Wrights built at Kitty Hawk between 1900 and 1908 (Crouch 1989:279-286). The 1904 and 1905 hangars were small, ephemeral structures which may have rested entirely on top of the ground. Following departure of the Wrights in 1905 to market their invention, varying accounts state that the 1905 Hangar was moved and used as a cowshed (Walker and Wickam 1986:3-4), or dismantled for its lumber by the Huffman family or (more likely) their tenants (Howard 1987:185).

The 1910 Hangar was a much more substantial, intensively used, and longer-lived structure. It was erected a short distance from the 1905 Hangar (see Figure 2), on land the Wright brothers and their aircraft production business, the Wright Aeronautical Company, rented to train pilots and test newly-built airplanes (Crouch 1989:426, Howard 1987:353-354). This facility also supported the Wright Company's efforts in the air show business, a major part of the Wright brothers' endeavors between 1910 and 1911 (Crouch 1989:424-439, Howard 1987:352-361). The Huffman Prairie field was called "Simms Station" in these years, after the nearby interurban stop (Howard 1987:354). Pilots-in-training commuted from Dayton on the interurban, or they boarded at the Huffman farmhouse across Simms Road (Howard 1987:353-354). This hangar was shown without any label, on a map of the area prepared by the Miami Conservancy District in 1915 (Figure 3). As seen in this figure, it is southeast of the intersection of Simms Road and the Dayton and Springfield Turnpike.

This intersection is at Simms (aka Wright) Station on the Dayton and Springfield Electric Railroad, which paralleled the earlier turnpike (Babson 1994:10). The intersection exists to this day as the intersection of Symmes Road and Marl Road (formerly, the turnpike). Persistence of this landmark provided an important reference datum for the 1993 geophysical surveys and the 1994 archaeological investigations.

The hangar constructed in 1910 by the Wright Company at the Huffman Prairie Site was a large, frame structure (Figures 4 and 5). Photographs taken after its abandonment (Brown 1993) show a structure resembling a barn, with a low-peak, gable roof originally supported by trusses (Plates 1 and 2). The floor was constructed of wood planks supported by joists. The doors to the hangar were large, wooden rectangles, which hung from tracks extending some distance past the side walls of the building. These door tracks were supported, beyond the hangar structure, by two simple post-and-lintel trestles, with two posts to either side of the south gable of the structure. Sway braces between these posts formed an "X," when viewed from the front (where the doors hung) or the back (Figure 4). Doors opening on a gable end and supported off the main structure of the building remain common characteristics of airplane hangars to this day. Windows were found in both gable ends of the roof. The roof covering, from the photographs (Brown 1993), appears to have been wood shingles, not metal sheets or other, "modern" roofing (such as asphalt shingles). This observation was directly contradicted by the artifacts found at the 1910 Hangar locus in 1990 and 1994.

It is possible that the 1910 Hangar was built for the Wright Company by a local contractor who had experience in constructing wooden barns and other large-span industrial buildings. The hangar's structure, a balloon frame with posts extending into the ground for a foundation, is common to temporary industrial buildings and resembles the structure of early 20th century pole barns. This construction suggests that the Wright Company did not intend the 1910 Hangar as a permanent structure; the costs of such a structure may have been too great during their start-up phase. Construction of the 1910 Hangar by a Dayton-area barn/industrial building contractor has not, to date, been supported by historical documents. If this relationship can be proven, it will show a direct, ancestral connection between aircraft hangars and barns, in that the 1910 Hangar is one of the first buildings built as a aircraft hangar.

The 1910 Hangar functioned to store aircraft being tested or used in pilot training (Plates 1, 3, and 4). The area immediately surrounding the hangar probably served as a station for minor-to-medium repairs to these craft, as they were adjusted after manufacture or repaired after suffering damage at the hands of inexperienced pilots. It was photographed in this function from a Wright Flyer in the early spring, fall or winter of 1911. This extraordinary photograph (Plate 5) is one of the earliest aerial photographs taken from an airplane.

Of several pilots trained by the Wright brothers at Huffman Prairie and at their winter operations site in Montgomery, Alabama, Walter Brookins, Arch(ibald?) Hoxsey and Ralph Johnstone became the backbone of the Wright Company's exhibition pilot staff (Howard 1987:353-361). The deaths of Hoxsey and Johnstone in air crashes in 1911 may have influenced the Wright brothers to withdraw from the exhibition business in this year (Howard 1987:358-360). On May 25, 1910, Wilbur and Orville Wright flew together above Huffman Prairie for the first and only time in their lives. This flight violated an earlier rule intended to preserve one brother in the event of a fatal crash (Howard 1987:354, Jakab 1990:227). In the opinion of one of their biographers, this flight: "amounted to a tacit admission that the most important part of their work was done." (Howard 1987:354). On this

same day, Bishop Milton Wright, father of the Wright brothers and 81 years old, flew with Orville Wright over Huffman Prairie, urging him to fly higher and higher (Howard 1987:354, Jakab 1990:227).

One hundred and sixteen men and three women learned to fly at Simms Station during its operation from 1910 to 1916; their names are recorded on the Wright Monument that overlooks Huffman Prairie (Walker and Wickam 1986:14-15). In 1911, this number included Army Lieutenant Henry ("Hap") Arnold, later commandant of the Fairfield Air Depot (one of the institutional ancestors of WPAFB) and first Chief of the U. S. Army Air Force during World War II (Howard 1987:372, Walker and Wickam 1986:12).

By 1915, Orville Wright had tired of the business of producing airplanes and training pilots (Crouch 1989:466-468). Wilbur Wright had died of typhoid fever in 1912. Land in the area of the 1910 Hangar was being bought by the Miami Conservancy District to prepare for construction of Huffman Dam and the Huffman Retarding Basin, part of a system of dams and basins intended to protect Dayton from a recurrence of the disastrous flood of 1913. Orville Wright sold the Wright Company in the fall of 1915 (Crouch 1989:468, Howard 1987:404), and the 1910 Hangar was abandoned in February of the following year, though Orville Wright flew there, occasionally, as late as 1918 (Walker and Wickam 1986:14). The empty hangar stood until the early 1940s (Plates 6 and 7), as Wilbur Wright Field (and, later, WPAFB) grew up around it (Walker and Wickam 1986:14-15).

The 1910 Hangar was used at least once during the period of its abandonment. It was used to exhibit the 1903 Wright Flyer Kitty Hawk during the Dayton Air Show in 1924 (Walker and Wickam 1986:76). Photographs (Brown 1993) show extensive modifications to the hangar at this time (Plates 8 and 9). These include removal of the plank floor, removal of the rolling door trestles, permanent closure of the aircraft doors, cutting of two personnel doors through the closed aircraft doors, construction of a frame ticket booth on the south side of the hangar, and construction of post-and-wire fences for crowd control (Plate 9). Interior posts may have been added during remodeling for the 1924 Dayton Air Show, or they may have been added as props to support the hangar roof trusses sometime after the Air Show. Lumber from parts of the hangar removed during the 1924 remodeling (specifically, supports for the door tracks; Brown 1993:1) was re-used for these props. This program of remodeling, both before and after the 1924 Air Show, probably modified the archaeological features that were created when the 1910 Hangar was first constructed. It also created new features. This complex of features, dating from 1910, 1924 and, possibly, after 1924, constitutes the archaeological record of the 1910 Hangar.

Between 1924 and the early 1940s, the 1910 Hangar deteriorated in place (Plate 10). It was fairly dilapidated by the time of its demolition (Brown 1993). While the hangar underwent no intentional changes at this time, the area around it was altered. These changes were first a result of property clearances in the area by the Miami Conservancy District after 1915, and by Wilbur Wright Field after 1917. The Dayton and Springfield Electric Railroad was removed from its original alignment on the west side of the Springfield Turnpike (Babson 1994:12). It is also likely that, during this time, Symmes Road was removed from its original course southeast of the Springfield Turnpike (see Figure 3). Symmes Road is present in the 1911 aerial photograph (Plate 5) and is mentioned in contemporary accounts of the use of the Huffman Prairie Flying Field (Brewer n.d.), but is absent, southeast of the Springfield Turnpike in the 1924 aerial photo (Butler et al. 1994).

The 1910 Hangar was torn down in the early 1940s; (General Henry "Hap" Arnold noted that the hangar was gone in 1949; Walker and Wickam 1986:14). It appears to have been demolished during removal of old buildings at Wright Field in preparation for new construction before and during World War II. Records specifically concerned with this demolition have not been found. The demolition may have been accomplished by a crew using a bulldozer or other earthmoving machine. The burnt artifacts (approximately 6.5% of the 1994 collection) found during both investigations suggests that at least some of the demolition debris were burned on site. The presence of a 20 cm layer of disturbed soil suggests the hangar area was plowed at least once after demolition.

No new construction has occurred in the immediate area of the 1910 Hangar, and the site has remained largely undisturbed since the hangar was removed (Crouch 1989:510-511, but see also Landreth 1990). The only exception was the installation of a small concrete pylon, placed in 1941 by Orville Wright near the location of the 1905 Hangar (Walker and Wickam 1986:336). A bronze marker (found by WPAFB surveyors in 1990) was placed at the location of the 1910 Hangar, probably at this same time. Surface debris and, certainly, living memory could pin-point the hangar location with great accuracy. The 1910 Hangar may even have been standing when the monument was installed in 1941. The bronze monument and the concrete pylon were constructed as a link to the establishment of the Wright Brothers Memorial on nearby Wright Brothers Hill (Walker and Wickam 1986:14-15). The bronze surveyor's monument was replaced by a bronze plaque on a concrete pedestal between 1990 and 1993, at a location approximately seven meters southeast of the original location. Removal of the original marker complicated the 1994 archaeological investigations; this issue is discussed in detail in Chapter 6.

The historical significance of the 1910 Hangar derives, in part, from its association with the Wright brothers and the Wright Aeronautical Company. It also derives from the use of this hangar at the very beginning of aviation as a site where some of the world's first pilots were trained and early aircraft designs were tested. Archaeological remains of the 1910 Hangar locus of the Huffman Prairie Flying Field site include artifacts and features which can be studied to advance our present understanding of early pilot training and aircraft operations. The hangar structure itself, as a complex of archaeological features, may also provide detailed information on the design and construction of one of the world's earliest airplane hangars.

Wright-Patterson Air Force Base

Established as an Army Signal Corps base in 1917 (Walker and Wickam 1986:25-27), Wilbur Wright Field was the first institutional and territorial ancestor of Wright-Patterson Air Force Base. Wilbur Wright Field was established around the recently-abandoned Simms Station site of the Wright Aeronautical Company, partially due to the recommendation of Orville Wright that the area could serve as one of the training bases the United States needed urgently as it prepared to enter World War I (Walker and Wickam 1986:25). More importantly, the Miami Conservancy was acquiring most of the land in the area at this time, allowing the Army Signal Corps to negotiate with one landowner (Walker and Wickam 1986:25). Another factor undoubtedly was the flat, floodplain topography of the area, well-suited for an airfield. Following World War I, Wilbur Wright Field and its successor, Wright Field, absorbed several other facilities, most notably McCook Field from Dayton in 1927 (Walker and Wickam 1986:85-114). During the years between World War I and World War II,

Wright Field became the U.S. Army Air Corps' major research and development base (Walker and Wickam 1986:204-256). It participated in the development and flight testing of many of the pursuit and bombing aircraft used by the Allied Air Forces in World War II (Walker and Wickam 1986:223-248).

Patterson Field was established immediately adjacent to Wright Field in 1931. It was named for a test pilot and scion of a prominent Dayton family (the Pattersons associated with the National Cash Register Company) who was killed in a crash at Wilbur Wright field in 1918 (Walker and Wickam 1986:258-259). Patterson field incorporated the Fairfield Air Depot (which continued to retain its name), and fulfilled important logistics functions, especially in World War II (Walker and Wickam 1986:259-291). Following the establishment of the U.S. Air Force in 1948, Wright Field and Patterson Field were merged into Wright-Patterson Air Force Base (Walker and Wickam 1986:293).

In 1949, the 2750th Air Base Wing was established to provide operating support for the new, consolidated base (Walker and Wickam 1986:295). To this day, Wright-Patterson Air Force Base continues its traditions of logistics support by hosting the Air Force Materiel Command HQ and the Joint Logistics Systems Center, and of aeronautical research with the Air Force Research Laboratory and the Air Force Institute of Technology. In this, WPAFB reaches back to its roots as a place of early aeronautical experimentation at Huffman Prairie in 1904 and 1905, and to Huffman Prairie's function in support of the Wright Aeronautical Company from 1910 to 1916. This history is displayed and interpreted in the United States Air Force Museum, located in Area B of WPAFB , and itself descended from Army Air Corps antecedents going back to the 1930s (Walker and Wickam 1986:433-434). As the oldest research and development airfield in the world, Wright-Patterson Air Force Base continues to fulfill its historical functions as it approaches its second century.

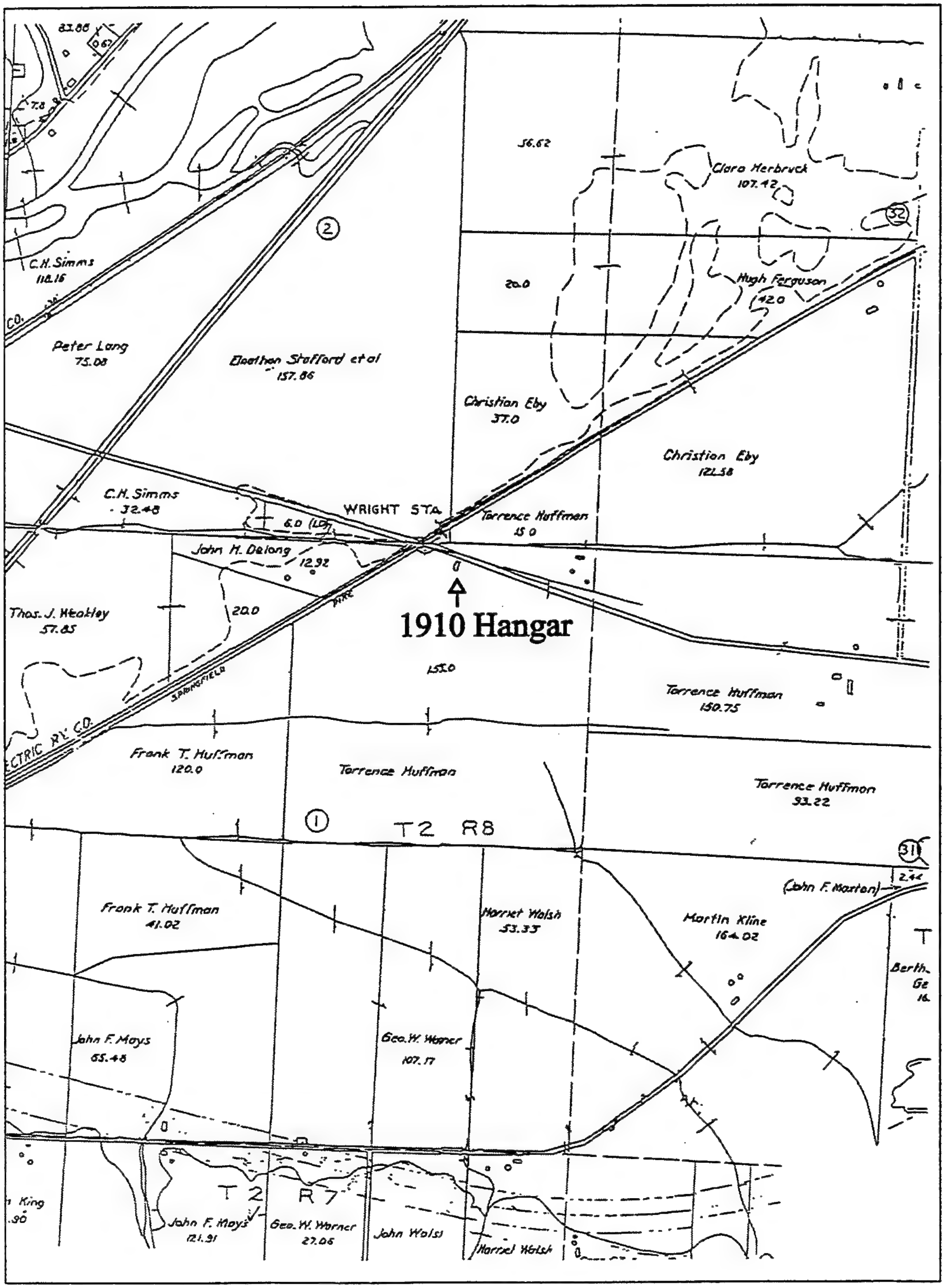

Figure 3. Location of 1910 Hangar on 1915 Miami Conservacy District Map

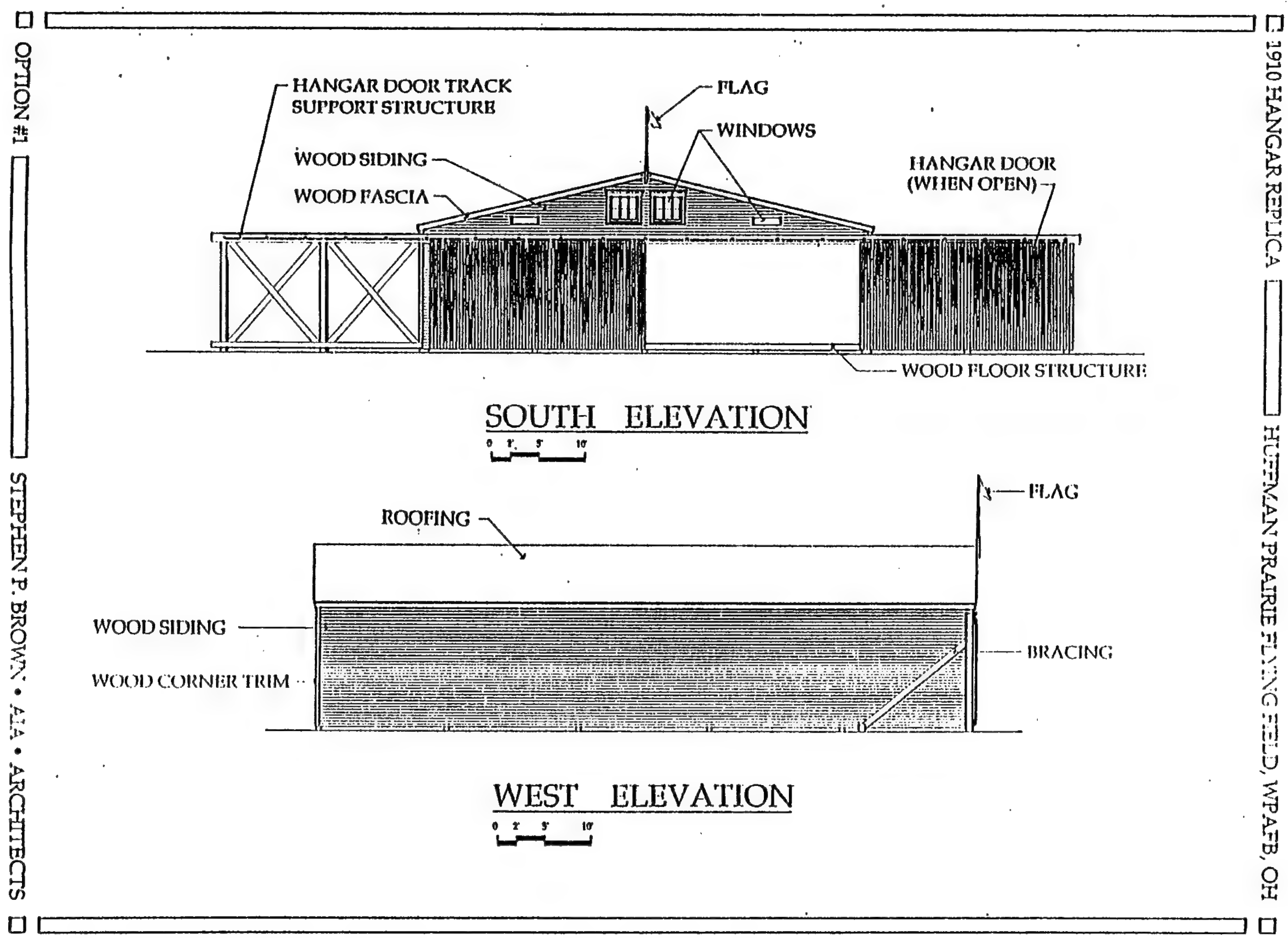

Figure 4. Architect's Plans for Replication of 1910 Hangar (Brown 1993)

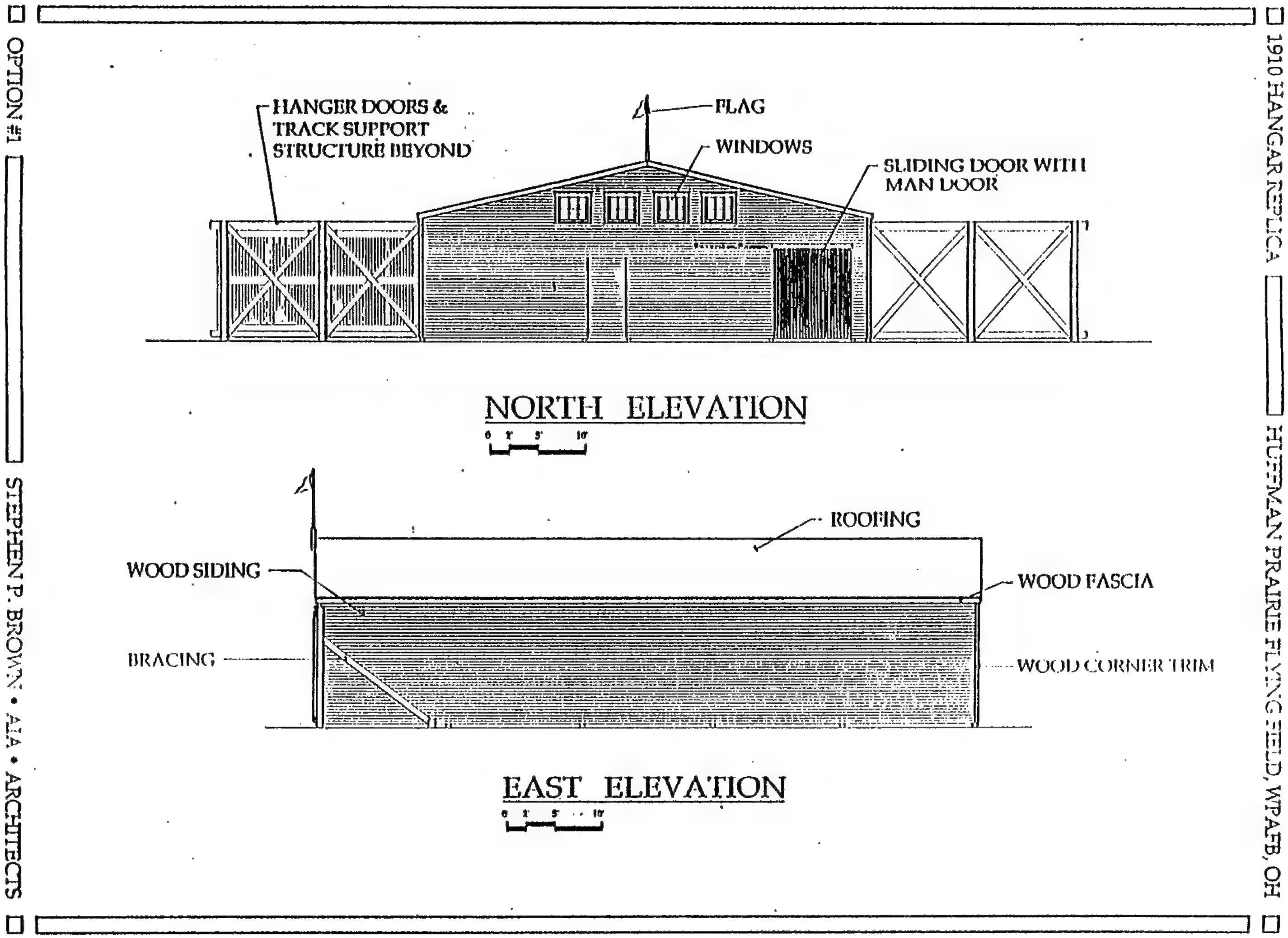

Figure 5. Architect's Plans for Replication of 1910 Hangar (Brown 1993)

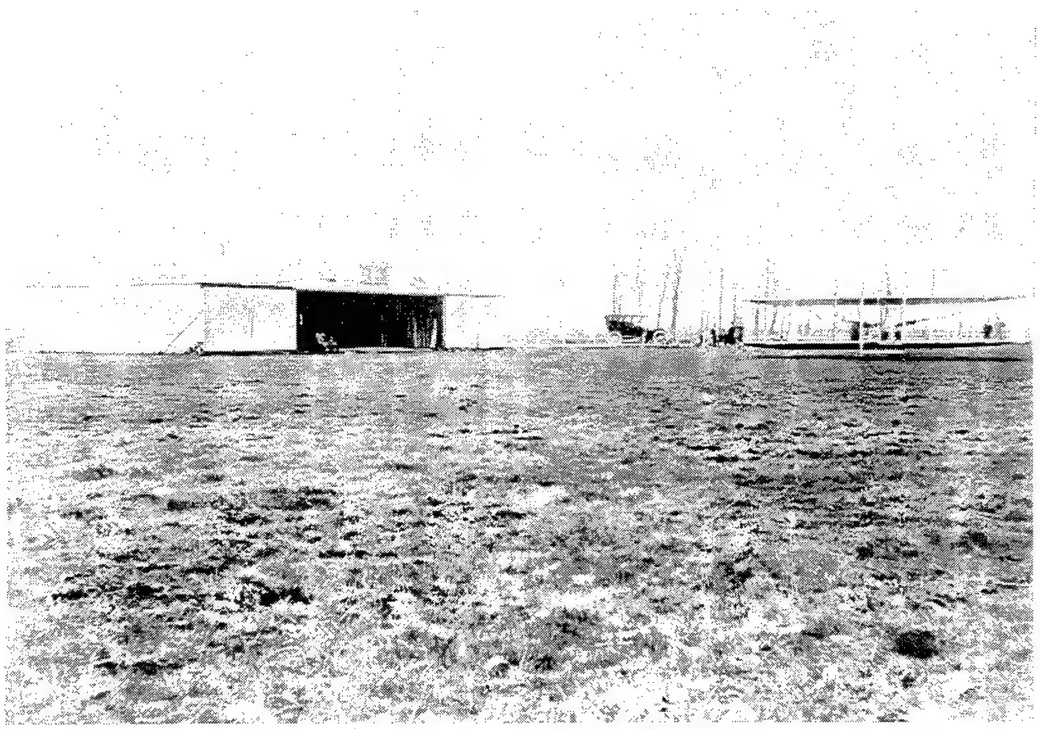

Plate 1. 1910 Hangar from the Southwest, 1910-1916. (U. S. Air Force Museum Photo).

Plate 2. Interior of Abandoned Hangar, After 1924. (U. S. Air Force Photo).

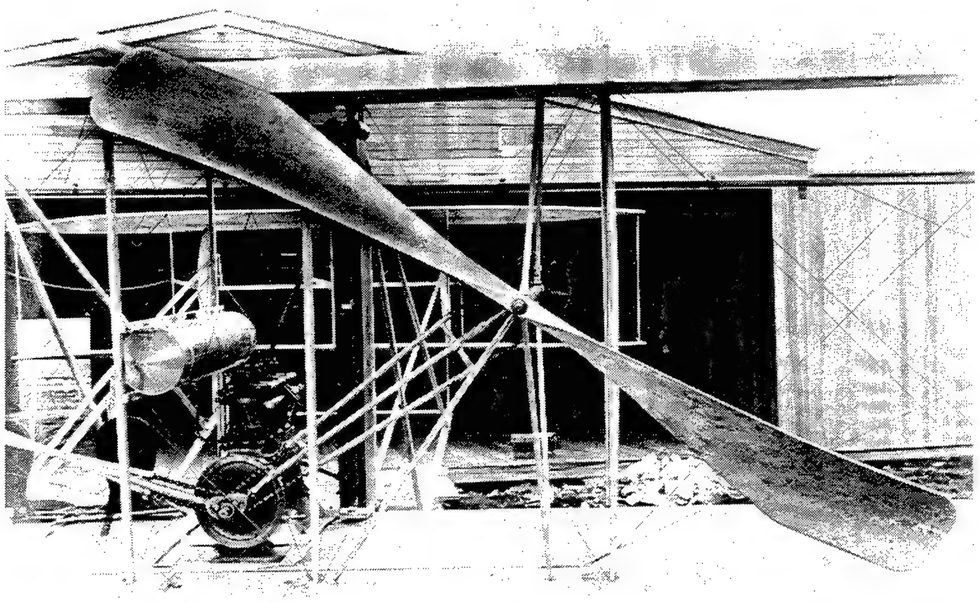

Plate 3. Wright Flyer in Front of Hangar Doors, 1910-1916. (Photo Courtesy of Wright State University).

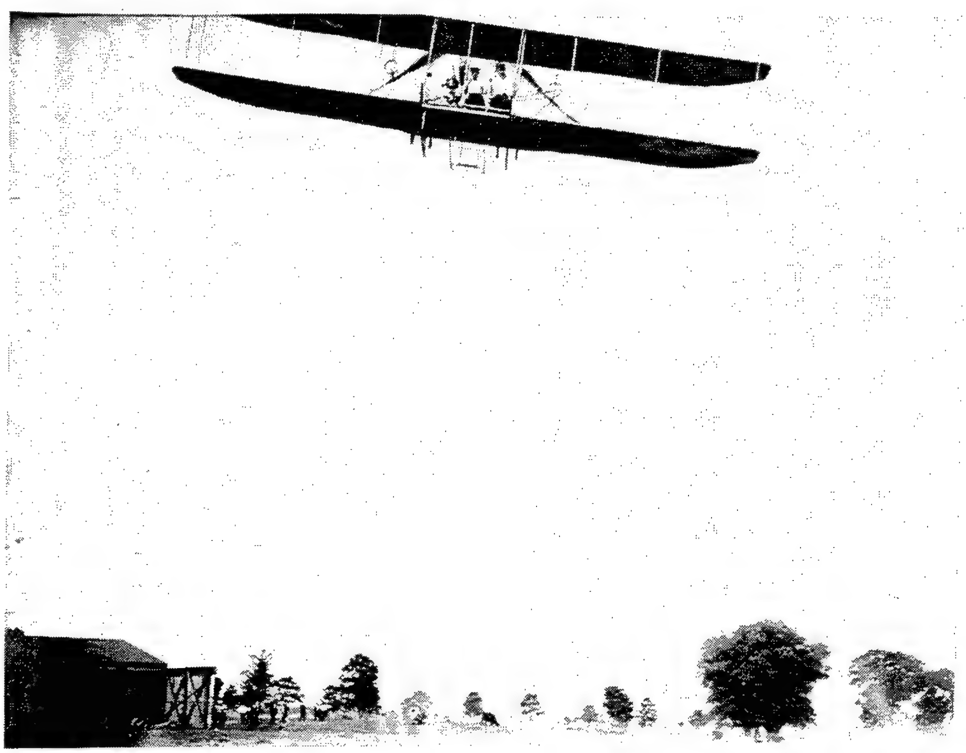

Plate 4. Wright Flyer Above 1910 Hangar, 1910-1916. (Source: Marvin Christian Collection).

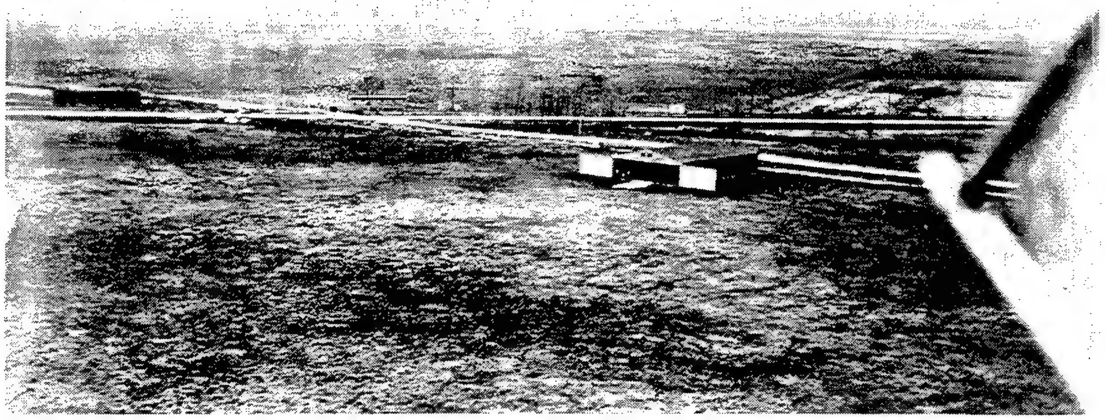

Plate 5. 1910 Hangar Photographed from a Wright Flyer, 1911. (Photo Courtesy of Wright State University).

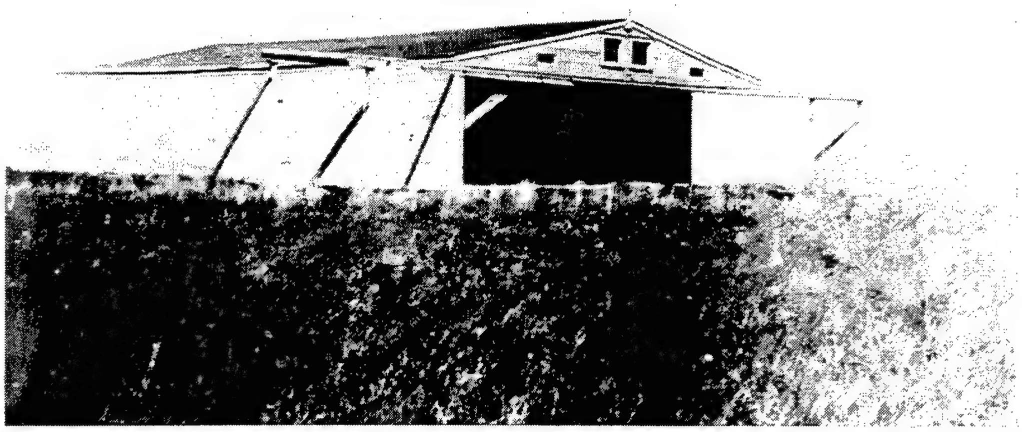

Plate 6. Abandoned Hangar from the South, 1916-1924. (U. S. Air Force Photo).

Plate 7. Abandoned Hangar from the North, 1916-1924. (U. S. Air Force Photo).

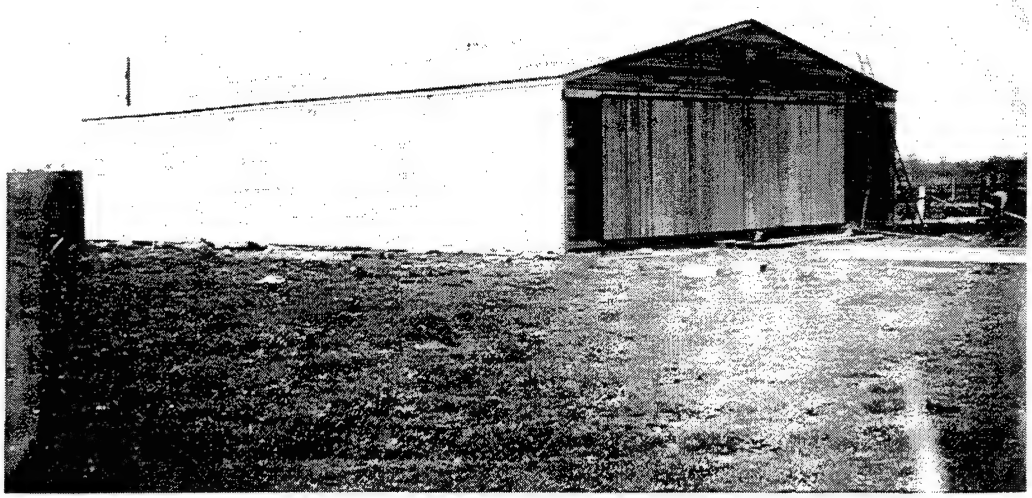

Plate 8. Hangar Being Remodeled Prior to 1924 Air Show. (Source: Marvin Christian Collection).

Plate 9. Hangar in Use During 1924 Air Show. (U. S. Air Force Photo).

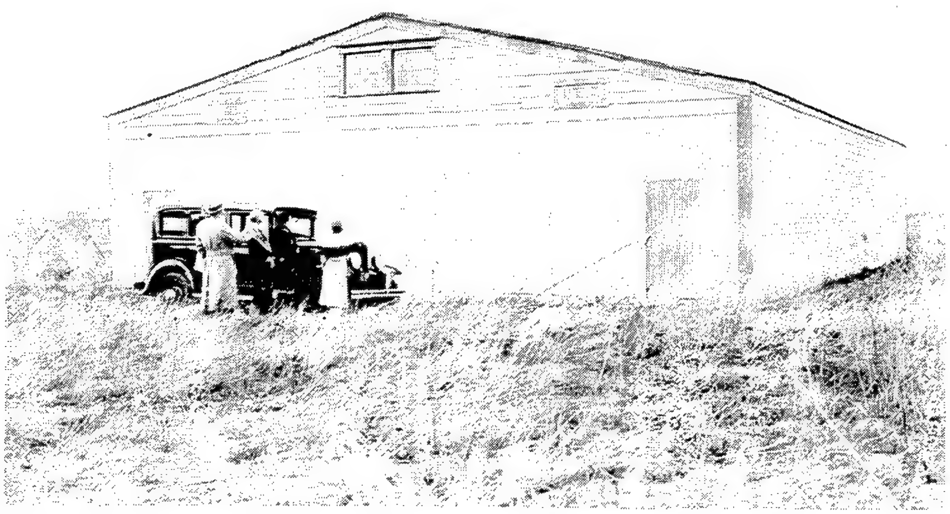
Plate 10. Hangar Abandoned Shortly After 1924 Air Show. (Source: Marvin Christian Collection).

Chapter 3
PROJECT HISTORY AND RESEARCH DESIGN

Project History

Investigations of the 1910 Hangar locus represent one aspect of a broader investigation of the Huffman Prairie Flying Field site. Only those aspects of the 1990 investigations focused on the 1910 Hangar locus are discussed here. The 1990 excavation strategy was based on the hand excavation of shallow trenches to identify large, shallow features such as a masonry foundation or well-defined drip lines. Although no such features were identified, the recovery of a large number of structural artifacts and a few Wright Flyer airplane parts (see Chapter 7) indicated the presence of the 1910 Hangar in the immediate vicinity.

The CEWES, NASA and 1994 USACERL investigations developed out of the failure to find in situ architectural remains in 1990. The remote sensing and geophysical surveys were intended to identify the exact location of the 1910 Hangar while minimizing additional disturbances to the site. The 1993 CEWES investigations consisted of magnetic, electromagnetic and ground-penetrating radar surveys (Butler et al. 1994:7-16). These surveys identified anomalies which corresponded to the location of the 1910 Hangar as shown on an aerial photograph taken in 1924 (Butler et al. 1994:30-38). The NASA study, which took place May-August, 1993, used color infrared photography and thermal infrared sensors and identified a subtle rectangular feature interpreted as the 1910 Hangar's "footprint" (Sever, Appendix A).

The 1994 USACERL investigations were undertaken to ground-truth (verify through excavation) the information provided by the CEWES survey; results of the NASA study were not available at the time of the 1994 excavation. By this time, it had been determined (Brown 1993) that the 1910 Hangar was a post-in-ground structure, without a masonry or otherwise highly-visible foundation. The 1994 excavation strategy was based on the use of large hand excavated units and limited machine testing to increase the likelihood of identifying architectural remains. The 1994 excavations succeeded in locating several subsurface features, including an in situ wooden post, a posthole, and a possible posthole. The identification of these features suggests that the Huffman Prairie Flying Field Site includes additional well preserved, in situ architectural remains associated with the 1910 Hangar.

1990 USACERL Research Design

The goal of the 1990 investigation was "to provide locational information on features and structural remains associated with the 1904-05, 1910-1916 Wright brothers occupation(s)." This information was intended to support "recommendations regarding the protection, preservation, and interpretation of archaeological remains at the site." (Landreth n.d.)

The 1990 investigations began with an examination of historical maps, documents, and other sources (Landreth n.d.:7-8), followed by pedestrian survey and soil chemical tests (Landreth n.d.:9-11). Excavation methods focused on the use of 1 X 1 m. units and shallow, hand-excavated trenches designed to document artifact distributions and to encounter large-scale features such as a masonry foundation or well-defined drip lines.

The goal of the 1990 artifact analysis was to assign artifacts to descriptive and functional categories that would contribute to inferences about the nature of activities conducted at the site. Descriptive analysis concerns the place of origin, manufacturing technology and date(s) of manufacture of artifacts (Landreth n.d.:15). Functional analysis focuses on the manner or context in which an artifact was used (Landreth n.d.:15-16).

CEWES and NASA Research Designs

The CEWES investigation included ground-penetrating radar, electromagnetic, and magnetic surveys (Butler et al. 1994). Anomalies identified using each method were assessed as possible indications of the hangar. Anomalies detected by multiple methods were viewed as particularly promising. The anomalies were interpreted in comparison to air photos (1924) and historical maps (Miami Conservancy District 1915) which show the 1910 Hangar structure (Butler et al. 1994:7-8).

The 1993 NASA survey employed two airborne sensors, the Calibrated Airborne Multispectral Sensor (CAMS) and the Inframetrics scanner, to search for thermal signatures associated with remains of the 1910 Hangar. As in the geophysical study, the NASA investigators correlated the thermal images with early air photographs and maps showing the position of the 1910 Hangar. Detailed research designs for the CEWES and NASA surveys are provided in the reports on those investigations (Butler et al. 1994; Sever, Appendix A).

1994 USACERL Research Design

The 1994 fieldwork was designed to ground-truth the findings of the CEWES geophysical survey (Butler et al. 1994). Interpretations of the features found during excavation as possible remains of the 1910 Hangar relied heavily upon an examination of archival photographs of the building. These photographs were also used to generate expectations about the arrangement of hangar foundation posts.

The 1990 excavations indicated that soil color and texture characteristics of the Huffman Prairie Flying Field site would make it difficult to recognize features related to the hangar. The most effective method for locating features would be to strip the uppermost soil stratum from the area where the geophysical survey identified evidence for the hangar. Clearing a wide, flat area to expose features is a standard archaeological technique for exploration of post-in-ground structure foundations, often used on late prehistoric and historic period sites in the Midwest and Mid-Atlantic states (Bareis and Porter 1983; Miller 1983). However, extensive mechanized earthmoving would clearly result in an unacceptable level of disturbance to the site. The 1910 Hangar is part of a National Historic Landmark site, and a dense surface scatter of artifacts related to the hangar had been identified in 1990. Excavation was therefore restricted to very limited mechanized stripping and hand excavation of 2 X 2 m. units. Excavations were focused on an area comprising approximately 1/8 of the 1910 Hangar as it had been demarcated by the CEWES geophysical study. The targeted area extended slightly beyond the hanger boundaries so as to increase the chances of locating wall remains. Execution of this approach was impeded by problems in coordinating the CEWES survey and the USACERL excavation grids (see Chapter 6).

Chapter 4
REMOTE SENSING AND GEOPHYSICAL STUDIES

Need for Remote Sensing and Geophysical Studies

Remote sensing studies at the Huffman Prairie Flying Field site were recommended when the program of hand excavations conducted in 1990 did not locate architectural remains of the 1910 Hangar. An analysis of artifacts recovered in 1990 did indicate that the hangar had stood in the area investigated. The 1990 study did not, however, establish the presence of any archaeological features or other subsurface remains of this structure. Location of such remains became the focus of the geophysical and remote sensing projects described here (Butler et al. 1994; Sever, Appendix A), and of the 1994 ground-truthing excavations.

Remote sensing and geophysical prospecting have, over the past twenty years, emerged as viable strategies to locate and investigate archaeological sites (David 1995, Lyons and Mathien 1980, Weymouth 1986). Geophysical prospecting offers the possibility of locating features without the disturbance that is inevitably caused by excavation (Von Frese and Noble 1984:51). Geophysical techniques are particularly appropriate for historical sites, which tend to have relatively large and well-defined features. Such features are more easily detected by magnetometry, soil resistivity or ground-penetrating radar surveys (Von Frese and Noble 1984:50-52) than are prehistoric hearths, pits or postmolds. Magnetometry techniques, which measure anomalies in the earth's magnetic field caused by archaeological features or by large concentrations of ferrous materials, are especially appropriate on historic sites. These sites frequently contain large concentrations of nails or other iron objects that correspond to locations of structures, other features, or refuse deposits within a site (Von Frese and Noble 1984:51). Geophysical investigations typically employ several methods (Butler et al. 1994:7, Weymouth and Woods 1984, Von Frese and Noble 1984:51-52) so as to ensure that a maximum number of anomalies will be observed.

This strategy of multiple survey methods was employed in the geophysical and remote sensing investigations of the 1910 Hangar locus. The CEWES geophysical investigations (Butler et al. 1994) included magnetic, electromagnetic and ground-penetrating radar techniques. The NASA remote sensing investigations (Appendix A) included two thermal sensors as well as color infrared photography. Although the target of these surveys (the 1910 Hangar) was an ephemeral, post-in-ground structure, both investigations were able to locate indications of the hangar structure.

Geophysical Investigations

The goal of the investigations conducted by CEWES in October, 1993, was to identify geophysical anomalies that might indicate the presence of archaeological remains of the 1910 Hangar (Butler et al. 1994:6). Background research involved digitizing a 1924 aerial photograph that showed the position of the 1910 Hangar relative to local landmarks such as the intersection of Symmes Road and Marl Road/Dayton and Springfield Turnpike (Butler et al. 1994:8). Field work began with the establishment of a 4 m. survey grid covering an area 68 m. north-south by 100 m. east-west. Marker Pylon 6 (the northwest pylon, see Figure 2) was used as the grid's northwest corner (Butler et al. 1994:13-17). Grid points were marked by plastic (nonconductive) pin flags. This grid was used for

the ground-penetrating radar, magnetic, and electromagnetic surveys. Technical details of these surveys are described by Butler et al. (1994:8-13).

The magnetic survey did not definitely locate the 1910 Hangar (Butler et al. 1994:18). An intense magnetic anomaly (Magnetic Anomaly B) was interpreted as a large, ferrous object of not more than 3.5 m. in depth (Butler et al. 1994: Table 1). This anomaly is in the southwestern quadrant of the artifact concentration identified in 1990 (Figure 6).

The electromagnetic survey relocated Magnetic Anomaly B and found 12 smaller anomalies southwest of the artifact concentration identified in 1990 (Butler et al. 1994:25, Figure 14). These anomalies are believed to represent shallow concentrations of metallic objects (Butler et al. 1994:25), probably nails and other ferrous artifacts from the above-ground parts of the hangar (Butler et al. 1994:42).

Ground-penetrating radar revealed a rectangular anomalous area and numerous localized anomalies (Butler et al. 1994:38). The latter were found in the same area where the highest concentration of electromagnetic anomalies were located, a finding held to be highly significant (Butler et al. 1994:38). These two groups of anomalies also corresponded fairly well with the position of the hangar, as projected from the 1924 aerial photograph (Butler et al. 1994:38, Figures 23 and 24).

CEWES recommended archaeological test excavations in the area where the electromagnetic anomalies, ground-penetrating radar anomalies and the 1924 aerial photograph all indicated the presence of the 1910 hangar structure (Butler et al. 1994:38). This was, in essence, the investigation strategy followed by USACERL in 1994, although field implementation of this recommendation was impeded by the 1990 removal of the 1941 bronze monument that had served as a local datum for the 1990 excavation grid.

Remote Sensing Investigations

NASA's remote sensing survey of the 1910 Hangar locus included the use of color infrared photographs and two thermal sensors: the Inframetrics and CAMS scanners. The Inframetrics scanner is described as "one of the most powerful thermal instruments commercially available at this time" (Sever, Appendix A). Data were collected in flyovers of the Huffman Prairie Flying Field on May 11 and 12, 1993 (Appendix A). Data were also collected, on August 4, 1993, using a Calibrated Airborne Multispectral Scanner (CAMS), an experimental infrared photography system then being developed by NASA. These data were combined into photo mosaics and analyzed with reference to the 1911 Wright Flyer aerial photograph of the 1910 hangar (Plate 5), and to the 1915 Miami Conservancy map (Figure 3) which shows the location of the hangar (Appendix A). The relict course of Simms/Symmes Road, south of Marl Road (the Dayton-Springfield Turnpike) appears clearly in these photographs. The CAMS images showed what was probably the road itself, whereas the Inframetrics image shows the gullies that flanked the road (Appendix A). The CAMS data also revealed a very subtle rectangular feature. This feature seemed to approximate the position and dimensions of the 1910 Hangar (Appendix A) as indicated by early air photos. The Inframetrics scanner produced a more clearly discernable image of a dark, rectangular area. NASA concluded that this feature might well represent the footprint of the 1910 Hangar (Sever, Appendix A).

Summary

Both the geophysical and remote sensing programs undertaken at the Huffman Prairie Flying Field in 1993 revealed evidence for the hangar in the expected location based on contemporary maps and photographs. The CEWES study located electromagnetic anomalies corresponding to the artifact concentration noted in 1990 (Butler et al. 1994:42). Ground penetrating radar located a rectangular anomalous area that corresponded to the location of the 1910 Hangar as digitized from the 1924 Air Photo (Butler et al. 1994:38, Figures 23 and 24). The NASA remote sensing survey located a very subtle anomaly that also corresponded with the location of the 1910 Hangar (Appendix A).

The most probable explanation for the Inframetrics image is that it corresponds to the footprint of the hangar. This footprint could be produced either by archaeological features associated with the hangar structure or by differential use of the area in and around the hangar. None of the historic photographs of the hangar show rain gutters, so the Inframetrics image may be, at least in part, a product of drip lines. Also, the hangar had a raised, wooden floor during its use from 1910 to 1916 (Brown 1993), whereas the relatively-soft ground surface around the hangar was compressed by use of the flying field. In particular, such compression could have been caused by maneuvering aircraft in and out of the hangar and by repair work on aircraft taking place outside the poorly lit structure. If the wooden floor protected the area immediately under the hangar from six years of compression, this might produce the rectangular image seen as infrared images and ground-penetrating radar anomalies. Of course, earthmoving during demolition of the hangar may have disrupted the hangar footprint and damaged evidence of soil compression. The magnetic and electromagnetic anomalies probably relate to concentrations of magnetic artifacts from the hangar structure, or from use of the hangar by the Wright Aeronautical Company from 1910 to 1916. While none of these anomalies were directly observed, they do support the persistence of the 1910 Hangar as a subsurface deposit. Confirmation of the presence and integrity of this archaeological site was achieved by the 1994 USACERL investigations, which are described in the following chapters.

Chapter 5
ARCHAEOLOGICAL FIELD AND LAB METHODS

1990 Field Methods

USACERL archaeological investigations of the 1910 Hangar locus took place in August of 1990. The purpose of this work was to locate remains of the hangar structure in an area marked by a dense surface scatter of artifacts that included nails, glass and other structural materials. This area was also marked by a bronze monument erected in 1941 (Walker and Wickam 1986:72, 336). Results of the 1990 excavation program are presented in Chapter 6.

The 1990 research design (Landreth n.d.) called for judgmental placement of test units, with a maximum unit size of 1 X 1 m. Units were surveyed from an arbitrary datum at 500N/400E. This point corresponded to the location of the bronze monument erected in 1941, and removed in 1990. This datum was 100 meters west of point 500N/500E which was set up as the main site datum. A concrete and rebar marker was set in at 500N/500E in 1990, and this marker was found in place during the 1994 investigations. Test units were laid out using an EDM (electronic distance measurement) instrument and metric tape.

The 1990 research design (Landreth n.d.) specified a maximum unit depth of 10 cm. below the existing ground surface. It became apparent during fieldwork that this depth was too shallow, and so units were dug to a maximum depth of 20 cm. below surface. The standard unit employed in the 1990 investigations was 1 X 0.5 m. in size, with units aligned to form trenches (Figure 6). These trenches were intended to locate hangar remains by cutting across structure foundations or drip line features (Landreth n.d.). Areas of particular interest, were explored with additional 1 X 1 m. units. Additional 1 X 1 m. and 1 X 0.5 m. units were placed so as to sample other portions of the site. The southeastern corner of each test unit served as the datum and the coordinates of this corner were used to designate the unit. Each unit was excavated as a single 20 cm. level, as stratigraphic divisions were not observed within the dense, dark-colored soil matrix encountered on Huffman Prairie. All excavated soil was screened through 0.25 in. mesh hardware cloth.

1994 Field Methods

Site Grid

The metric grid established by USACERL archaeologists at the site in 1990 was used in the 1994 work. The remains of a wood stake which had marked the 500N/400E datum were relocated. Using an optical transit set at that point, wood stakes were set at 5 m. intervals along the 500N line from 370E to 400E, and along the 400E line, from 500N to 470N. The grid coordinates of hand excavated and machine units were determined using crossed tapes extended off these two base lines.

Demarcation of Hangar Location

The 1994 field work began with an attempt to flag the location of the 1910 hangar. USACERL archaeologists based their inferences about the hangar location on a careful inspection of the 1915 Miami Conservancy District map (Figure 3). An optical transit set at the intersection of Simms and Marl roads north of the creek and abandoned railroad embankment (of the Dayton and Springfield Electric Railway) was used to extend the axis of Simms Road 115 m. to the southeast. The transit was then moved to that location, turned 90 degrees off the Simms road axis, and a point was set 22.9 m. to the southwest. This point, marked by a pin flag, was assumed to correspond to the approximate location of the northwest corner of the hangar. The other three corners of the hangar were then flagged, based on the dimensions and orientation of the building (approximately 21 m. northeast-southwest by 15 m. northwest-southeast) as suggested by an earlier analysis of photographs (Brown 1993; Butler et al. 1994:1).

A second location for the hangar was also flagged using data reported by Butler et al. (1994). In the field, it was found that the flagged location of the hangar based on the CEWES study was approximately 4 m. north and 14 m. west of the location based on USACERL's 1994 inspection of the 1915 map. The two flagged locations were nearly contiguous but did not overlap.

Following the completion of the 1994 field work, it was found that the CEWES and USACERL grids were slightly offset. CEWES personnel had assumed that the position of the 1941 bronze marker, designated as 500N/400E in the 1990 USACERL grid, was within 2 m. of the present concrete monument (Butler et al. 1994:1, 16). In fact, the 1941 marker was located some 5 to 7 m. southwest of the concrete monument; (the northwest corner of the monument is 494.7N/406.97E). This discrepancy is the result of removal of the 1941 bronze monument in 1990. As a consequence of this discrepancy, flags intended to mark the position of the hangar as inferred by CEWES were, in fact, mislocated. This error had several unfortunate consequences. Most notably, 1994 excavation units intended to investigate the south end of the hangar were later found to be within the central portion of the CEWES hangar location (Figure 6). Additionally, one of the 1994 units intended to investigate a particularly notable anomaly identified in the CEWES remote sensing study (Anomaly B) did not actually intersect its target. Despite this problem, all of the USACERL units intended to investigate the hangar did fall within the inferred limits of the building. The units excavated in 1994 did provide substantial information about the nature of the archaeological record of the 1910 Hangar.

Mechanized Excavation

Relatively limited mechanized excavations were conducted at the site. Two machines (both provided by WPAFB) were used: a front end loader with a wide smooth bucket, and a backhoe with a narrow bucket with teeth. Neither machine was particularly well-suited for archaeological excavations. The front end loader's bucket achieved a reasonably clean cut, but the freshly scraped surface was immediately obscured by the tire tracks as the machine moved forward. The effectiveness of the backhoe was diminished by the teeth attached to the bucket. Despite these limitations, the heavy equipment (particularly the front end loader) was useful, allowing exposure of an area much larger than could be exposed by hand excavation. Careful monitoring of the machine cuts resulted in the identification of several structural features related to the hangar.

Test Unit Excavation

Five units, each measuring 2 by 2 m., were hand excavated. The purpose of these units was to provide a controlled sample of artifact density, to document stratigraphy, and to investigate possible features and anomalies in a controlled manner. The 1994 units are designated using the grid coordinates of their southwest corner; (1990 units are named by the southeast corner). The units were excavated in arbitrary levels of 10 and 20 cm. Excavated soils were screened using .25 in. mesh. Clay soils too dense to be forced through this mesh were trowel-sorted, in the screens. Data relevant to each level were recorded on standardized forms. The base of each level was mapped in plan, and at least one of the unit walls was profiled.

Feature Excavation

The three features identified at the site proved to be quite variable and excavation techniques were modified as required by the situation. In general, each feature was mapped and photographed in plan and profile. Soil and artifacts contained within or otherwise directly associated with the features were removed as separate provenience units.

Backfilling

All hand and machine excavated units were backfilled at the completion of the USACERL fieldwork. Selected grid stakes were left in situ to expedite future work at the site.

1990 Laboratory Methods

Processing and laboratory analysis of the artifacts recovered by the 1990 USACERL excavations was conducted in 1990 and 1991 by the Midwestern Archaeological Research Center (MARC), Illinois State University. Processing of artifacts followed standards established for historical archaeology (Noel Hume 1974:257-292). Artifacts were washed in plain water with a stiff toothbrush and allowed to dry in screen trays. Artifacts were accessioned and placed in plastic bags marked with field proveniences. Field proveniences were maintained throughout the analysis. MARC submitted a report on the analysis and returned the artifacts to USACERL in September of 1991.

Analysis of the 1990 artifacts emphasized descriptive histories and functional analyses of artifacts (see Chapter 2). Very few chronologically-diagnostic artifacts were recovered in 1990, so an effort was made to estimate the date of manufacture of the flat glass (Roenke 1978). The functional analysis separated artifacts into three broad categories, domestic materials, structural materials (including window glass, iron nails, shingle fragments and other structural artifacts) and industrial materials. Airplane parts were included in the industrial material category. Results of this artifact analysis are presented in greater detail in Chapter 7.

1994 Laboratory Methods

Analysis of the artifacts recovered by the 1994 excavations was conducted at USACERL, in January and February, 1995. As with the 1990 artifacts, standard historical archeology practices (Noel Hume 1974:257-292) were followed, and field proveniences were maintained throughout the study.

With site dating established by historical research and by the 1990 analysis, artifact function was the focus of the 1994 analysis. As such, it is a continuation of the artifact analysis goals specified in the original project research design (Landreth n.d.:14). The 1994 analysis therefore proceeded by writing a descriptive catalog (presented here as Appendix B) of all the artifacts, organized by provenience. Dating information was included where appropriate, but emphasis was on artifact function. The analysis is intended to support functional identification of features and other field proveniences, to locate and describe archaeological remains of the hangar structure. This analysis strategy is intended to help fulfill the over-all project goals of identifying structural remains of the hangar and assessing their archaeological integrity. The 1994 analysis is discussed in greater detail in Chapter 7.

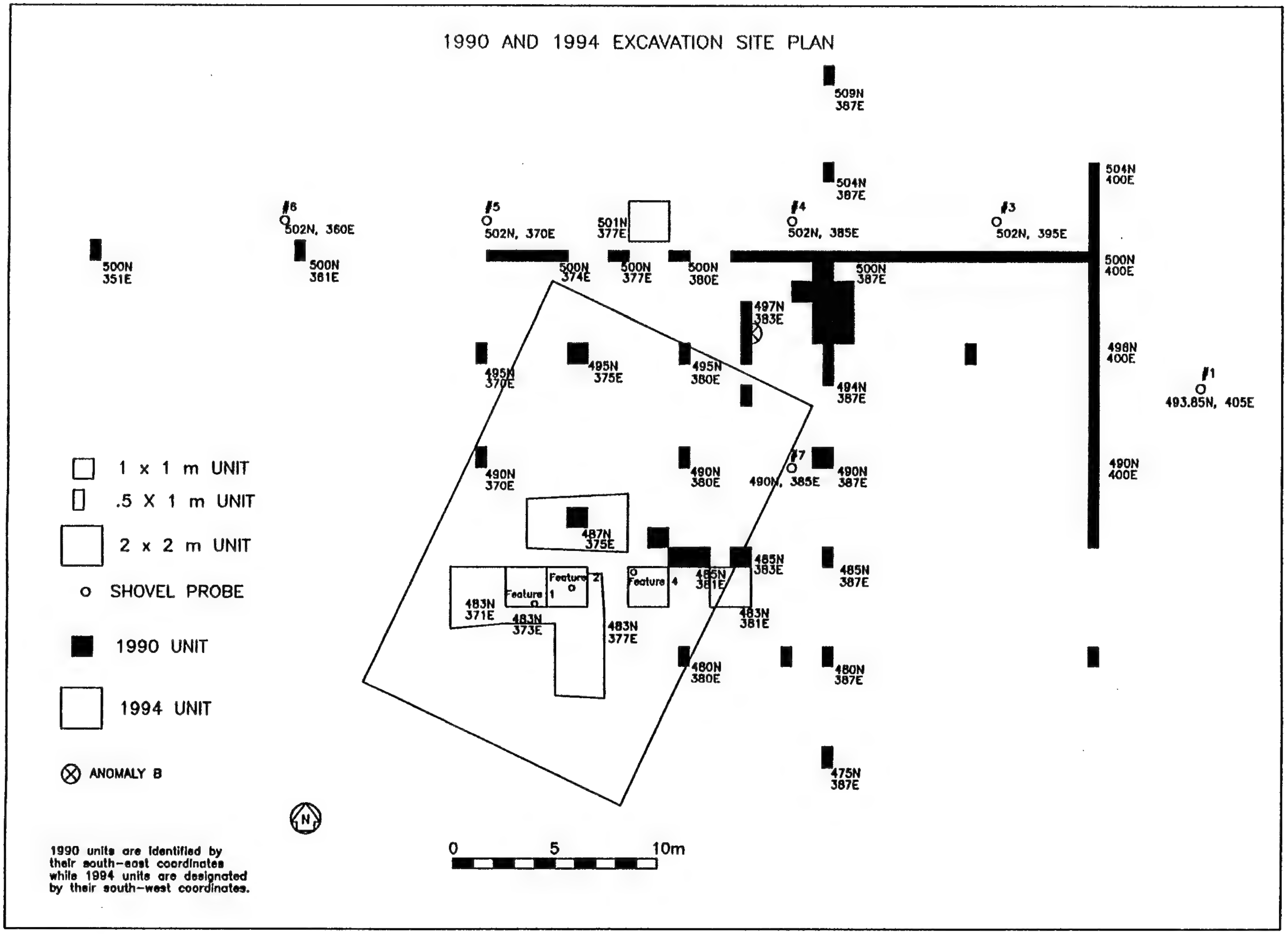

Figure 6. 1990 and 1994 Excavation Site Plan

Chapter 6
RESULTS OF ARCHAEOLOGICAL EXCAVATIONS

1990 Excavations

Fifty-eight 1 by 0.5 m. units and fourteen 1 by 1 m. units were excavated in 1990, exposing an area of 43 m^2. The distribution of these units is shown in Figure 6. Trench A, a series of aligned units from 500N/400E to 500N/382E (with out-lying units on the 500N line to point 500N/370E) crossed the densest surface concentration of artifacts. The Trench A units produced artifacts clearly derived from the 1910 Hangar. The block of seven 1 X 1 m. and two 1 X 0.5 m. units located south of 500N/387E further explored this artifact concentration. Units located south of this block did not encounter architectural remains of the hangar structure, but they did recover some noteworthy artifacts related to occupation and use of the 1910 Hangar. These items included a large piece of milled lumber in unit 485N/379E and a 1910 Lincoln penny in unit 490N/386E.

Failure of the 1990 program to identify definite structural remains of the 1910 Hangar may be explained by several factors. First, the majority of the 1990 units did not extend below the disturbed uppermost stratum, which was found in 1994 to be approximately 20 cm. thick. This disturbed stratum is very similar to the stratum that underlies it, in terms of soil color, but has a slightly different texture. The stratigraphic interface was rather difficult to discern in 1994. The narrow trenches excavated in 1990 stopped at or above the base of the disturbed stratum, allowing no opportunity to identify the interface in unit or trench profiles.

Second, the use of shallow, narrow trenches to intersect structure foundations or drip lines was not an appropriate strategy for the 1910 Hangar locus. It was not ascertained until after the 1990 excavations that the hangar was a post-in-ground structure, without a concrete, brick, stone or other substantial foundation (Brown 1993).

The 1990 excavations did produce useful information about artifact distributions at the 1910 Hangar locus. For example, artifacts comprising the artifact concentration around 500N/387E are overwhelmingly architectural in nature (nails, window glass and roofing shingle fragments). This concentration suggested the presence of the demolished hangar structure somewhere in the immediate vicinity of 500N/387E. Results of the 1990 work led to a recognition of the need for additional investigations employing alternative strategies. As noted, these investigations were the geophysical survey (Butler et. al 1994) and remote sensing (Sever, Appendix A) followed by the 1994 excavations.

1994 Excavations

The primary objective of the 1994 USACERL investigations at the Huffman Prairie Flying Field site was to identify in-situ architectural remains or other archaeological evidence of the 1910 Wright brothers Hangar. A related goal was to ground truth the results of the 1993 CEWES geophysical study (Butler et al. 1994). One constraint on the USACERL work was the need to disturb as little of the hangar site as possible. The 1994 field work included the machine excavation of two blocks exposing a total area of approximately 23 m^2, and the hand excavation of five 2 X 2 m. test units and 7 shovel probes. This work resulted in the identification of three architectural features which are very

probably related to the hangar, as well as a number of artifacts which are definitely associated with that structure.

Following the completion of the 1994 excavations, a discrepancy was found in the correlation between the CEWES and USACERL grids. As a result, 1994 excavation units intended to investigate the southern end of the hangar were actually located within the central portion of the structure (Figure 6) (as inferred by CEWES based on the 1924 Air Photo; Butler et al. 1994:38).

Machine Stripped Areas

Block A is an L-shaped area of approximately 15.5 m^2 (Figure 6). The block was excavated as three main machine trenches. Machine Trench 1 makes up the northwest portion of the block, whereas Machine Trench 2 corresponds to the northeast portion. The south portion of Block A corresponds to Machine Trench 3. The three machine trenches were separated by narrow unexcavated strips. Artifacts exposed on the stripped surfaces of the three trenches were collected as separate proveniences.

The front end loader began excavating in the north central portion of the block and almost immediately exposed Feature 1, an in-situ wood post; (features are described in detail in a following section). The block was expanded to the east and west, resulting in the identification of Feature 2, a square pit. Because of these features, and the possibility that additional features could be present, the machine did not cut deeper than approximately 5 to 15 cm below surface. Block A was then extended to the south. No additional features or noteworthy artifacts were identified in that area. In a series of shallow cuts, the machine eventually cut to a depth of approximately 15-20 cm. at the southeast corner of the block.

Block B was an east-west oriented rectangular area of approximately 7.5 m^2. The block was excavated using the backhoe, and the teeth on the bucket limited the effectiveness of the machine. Careful monitoring of the machine's operation yielded no evidence of additional in-situ architectural features. Several small pieces of non-carbonized wood much like those found in-situ in Feature 1 were recovered from the bucket. One of these pieces had an angle saw cut (see Artifact Catalog, Appendix B). Block B was excavated to a depth of approximately 25 cm. below surface. At this depth, the soil was a very blocky clay which could not be shovel scraped or troweled to a smooth surface.

Test Units

Five 2 X 2 m. units were hand excavated. Four of these (483N/371E, 483N/373E, 483N/377E, and 483N/381E) were located on the 483N line. These units extended to the east of the area investigated by Block A. The objective of these units was to allow a controlled excavation of the two features (Features 1 and 2) identified in Block A, and to search in a more controlled manner for additional features. The fifth unit (501N/377E) was intended to investigate a magnetic anomaly (Anomaly B) identified by CEWES (Butler et al. 1994:19). As explained above, the subsequent correction in correlating the CEWES and USACERL grids resulted in this fifth unit missing the targeted anomaly.

Unit 483N/371E: This unit was located within the west-central portion of Block A in order to allow a controlled excavation of Feature 1 (an in-situ wood post) and the immediately surrounding area (Figure 7). The east most edge of the unit (ranging in width from 12 cm. at the south to 35 cm. at the north) was not excavated. This edge corresponds to the eastern limits of Machine Trench 2 and represents an unexcavated balk between units 483N/371E and 483N/373E within Block A.

In several shallow cuts, the front end loader removed approximately 16 cm. of soil before encountering the uppermost portion of the Feature 1 post. Machine excavation ceased at that depth, and the unit was lightly shovel scraped and troweled, removing an additional 3 to 4 cm. of soil. The soil at the base of Level 1 (approximately 20 cm. below surface) was a black (10YR2/1) silt loam. Following the documentation of Feature 1, no additional excavation was conducted in this unit.

Unit 483N/373E: This unit was established within the east central portion of Block A in order to further investigate Feature 2 and its immediate environs. A strip ranging in width from 35 to 50 cm. along the west edge of the unit was not excavated. Elsewhere in the unit, the front end loader excavated to a depth of approximately 5 cm. below surface. Machine excavation ceased when the first indications of Feature 2 were noted. Feature 2 was excavated and documented at that level (Figures 8 and 9). The remainder of the unit (less the balk described above) was then hand excavated to a depth of 20 cm below surface. At that depth, the soil matrix was a culturally sterile blocky clay. The lowermost portion of Feature 2 was discernable in the Level 1 floor.

A tapered iron strap hinge (FS 4) was recovered at 483.30N/373.48E (see Appendix B). This location places the hinge at the interface of the excavated portion of the unit and the balk (Figure 8). Evidence for an association of this door hinge with the 1910 hangar is discussed in Chapter 7.

Unit 483N/377E: This 2 by 2 m. unit was located east of Block A in the hopes of identifying additional features associated with the hangar. Level 1 was hand excavated to a depth of 20 cm. below surface. The Level 1 soil was a black (10YR2/1) heavy silt loam with abundant pebbles and gravel. Level 1 essentially corresponds to an Ap horizon which had been disturbed by the demolition of the hangar and subsequent plowing in the 1940s (Figure 10). Several noteworthy artifacts were recovered near the base of Level 1. Protruding into the unit from the central portion of the north wall was a long iron object (FS 13) which may represent a wheel and shaft fitting. A second artifact (FS 12) was recovered near (40 cm. to the west of) FS 13 (Figure 11). This item, a metal eye mounted on the end of a shaft, is identified as a washer, presumably associated with the hangar structure. A third metal artifact (FS 14), probably a window sash weight or an aircraft weight, was recovered near the central portion of the east wall. Evidence for the association of the artifacts with the hangar is discussed in Chapter 7.

The base of Level 1 (at 20 cm. below surface) represented the upper limits of the 2Bt horizon (Figure 10). The soil at this depth was a very dark grey (10YR3/1) to grey (10YR5/1) blocky clay loam. Feature 4, a concentration of wood boards and shingles located in the extreme northwest corner of the unit, was documented at the base of Level 1 (Figure 12). Level 2 consisted of a 10 cm. level within the west one-half of the unit. With the exception of Feature 4, the 2Bt horizon was found to be undisturbed.

Unit 483N/381E: This square was the easternmost of the four 2 by 2 m. units excavated along the 483N line. Unit 483N/381E was begun prior to the identification of Feature 4 in 483N/377E. Features 1, 2, and 4 are in a northeast-southwest alignment, but Unit 483N/381E is positioned south

of this axis. Had Feature 4 been discovered sooner, Unit 485N/381E would have been excavated rather than 483N/381E.

The Level 1 soil was a black (10YR2/1) heavy silt loam with numerous pebbles and some gravel. The base of Level 1 ranged in depth from 20 to 24 cm. below surface. Artifacts recovered in the level included fragments of rotting wood much like those recovered near Feature 4. It was found that the upper 20 cm. was disturbed, presumably as a result of hangar demolition. The base of Level 1 was located just below the disturbed zone. The undisturbed soil of the Level 1 floor was a dark grey clay loam. No features or noteworthy artifacts were recovered in this unit. It was found that a 1 X 1 m. unit excavated in 1990 extended into the northeast corner of 483N/381E.

<u>Unit 501N/377E</u>: This 2 X 2 m. unit was intended to investigate Anomaly B, a major magnetic and electromagnetic anomaly identified by the CEWES geophysical study (Butler et al. 1994:18-21). Electromagnetic anomaly II (which corresponds to Magnetic Anomaly B) was described as a localized, low or negative anomaly believed to occur at a depth less than 3.5 meters (Butler et al. 1994:18, 25). Electromagnetic Anomaly II/Magnetic Anomaly B may represent a buried metallic object. Unfortunately, because of the error in correlating the CEWES and USACERL grids, Unit 501N/377E did not intersect this anomaly (see Figure 6).

Level 1 was excavated to a depth of 10 cm below surface. At that depth, the unit floor was a dark brown (10YR3/3) mottled with 10YR3/1 very dark grey compact silt loam. Small traces of "orangish brown" iron-like particles were evenly scattered across the floor. A relatively-square stain measuring about 15 cm. on a side was identified at 502.55N/377.35E. This stain was designated as Feature 3 and thought to be either a historic postmold or (more likely) a non-cultural disturbance. The Feature 3 fill was very dark grey (10YR3/1) and looser than the surrounding matrix. It was decided not to excavate Feature 3 at this level. The stain was no longer discernable at 15 cm. below surface, indicating that it was, most probably, a bioturbation.

Level 2 was excavated to a depth of 20 cm. below surface. At this depth, two major zones were observed in the unit floor (Figure 13). The boundary between the two zones was rather amorphous. The Munsell color of the western one-third of the unit was recorded as 7.5YR5/8 (strong brown). This heavy loam resembled the color of rusted iron, and this was undoubtedly the source of the rust colored particles observed in the Level 1 floor. The eastern portion of the Level 2 floor was a very dark grey (10YR3/1) heavy loam. This area was largely homogeneous, although a few small (20 cm. long) patches of the strong brown soil were also present. The appearance, texture, and overall feel of this very dark grey soil suggested the possibility that it had been impregnated by oil, conceivably discarded motor oil associated with aircraft housed at the 1910 Hangar.

Level 3 was excavated to a depth of 30 cm. below surface within the north most portion of the unit. Excavation was restricted to a 0.5 X 2 m. trench along the north wall of the unit. The Level 3 trench was intended to provide a profile (along the north wall of the unit) that would be informative about the origins and nature of the "orange" and possibly oil impregnated grey deposits (Figure 14). Level 3 produced several nails, but the overall number of artifacts was much lower than in Levels 1 and 2. Many irregularly-shaped pieces of iron were present, but these appeared to represent natural concretions rather than heavily rusted artifacts. The Level 3 trench floor showed a light grey subsoil with sparse small mottles of strong brown and bioturbations filled with darker soils from the upper levels.

In order to achieve a more informative profile in the north wall, Level 4 was excavated to a depth of approximately 70 cm. below surface. The culturally-sterile Level 4 soil was not screened. Following completion of the level, the north wall of unit 501N/377E was profiled (Figure 14). Soil descriptions were recorded by geomorphologist Larry Abbott. The profile revealed the presence of a 15 to 20 cm. plow zone (Ap). The "orange" iron-like stains were most common within an 8 to 25 cm. thick 2A zone, but one concentration of this stain also occurred in the underlying 2Bt zone. The presence of mottles between 30 and 42 cm. below surface suggested a fluctuation in the water table.

Features

A total of four feature numbers were assigned, although one of these (Feature 3) proved to be non-cultural in origin.

Feature 1: This feature was an in-situ wood post located at 483.15N/372.40E (see Figure 7). The reddish-orange colored wood was entirely non-carbonized and well preserved. The upper-most in-situ portion of the post was 16 cm. below surface. A 13 cm. length of the in-situ post was visible. The lower portion of the post extended into the ground and no portion of the remaining post was excavated. In plan, the in-situ post measured 12 cm. northeast-southwest by 14 cm. northwest-southeast. Truncation by the machine had not modified this orientation. Based on size, Feature 1 resembled a historic fence post (see discussion below). If this is the case, the orientation of the post may not provide a reliable indication of the orientation of the fence. If Feature 1 represents a wall post related to the hangar, the post must have been flush with the wall cladding, and the orientation of the post should suggest the overall orientation of the structure wall.

Feature 2: This was a small pit feature located at 484.05N/374.26E (see Figures 8 and 9). In plan, Feature 2 was more-or-less square with rounded corners, measuring 40 cm. north-south by 43 cm. east-west. This pit was identified at 5 cm. below surface and extended to a maximum depth of 29 cm. below surface. In profile, the west side of the pit was steeply sloping whereas the east side sloped up and outward at an angle of roughly 45 degrees. The base of the pit was flat, level, and about 13 cm. wide.

Feature 2 was defined within the uppermost stratum, a black silt loam. The lowermost portions of the pit extended slightly into the underlying light olive brown (2.5YR5/4) sandy clay. The pit fill was similar in color to the upper stratum silt loam but was looser and more friable. Artifacts recovered from the pit fill included nails, a shotgun shell casing, glass, and wood fragments.

Identification of Feature 2 at a depth of only 5 cm below surface poses an interesting problem. This small pit appears to be intrusive into the disturbed, uppermost soil stratum. Assuming that the soil was disturbed (by bulldozing and/or plowing) at the time of hangar demolition, Feature 2 would necessarily post-date the hangar. Feature 2's location near Features 1 and 4 would thus be viewed as coincidental.

Feature 3: This refers to a soil stain identified at 502.55N/377.35E in Unit 501N/377E (Figure 15). The stain was square, measured about 15 cm. on a side, and had a loose, very dark grey (10YR3/1) fill. Feature 3 was first observed at the base of Level 1 (10 cm. below surface). The stain was interpreted as a possible (but not very promising) historic postmold. An additional 5 cm. of the feature was shovel scraped during excavation of Level 2. At 15 cm. below surface, no traces of the stain remained. Feature 3 was consequently interpreted as a soil stain of non-cultural origin.

Feature 4: This feature consisted of a concentration of wood and roofing shingles within a pit located in the extreme northwest corner of Unit 483N/377E (see Figure 12). The feature continued into the north and west walls of the unit. The portion of the feature documented within the unit was centered at 484.80N/377.25E, and measured 53 cm. east-west and 43 cm. north-south. Feature 4 was first documented at the base of Level 1 (20 cm. below surface). The upper portions of the feature were presumably truncated by bulldozing and/or plowing associated with hangar demolition. In the north wall profile, it was apparent that the Feature 4 pit had a relatively flat and level floor. Most or all of the wood, roofing shingles, and other artifacts (including nails and glass) recovered within the pit appear to be secondary refuse. However, a probable postmold was identified within the feature. This postmold consisted of a roughly circular stain approximately 12 cm. in diameter, located at 484.N/377.20E. There was no evidence of an in situ post within this stain. The functional relationship between the Feature 4 pit and postmold remains unclear. It is conceivable that the pit was dug so that a post could be precisely aligned (with other posts), or so that a roof-support post that was slightly too long could be wedged into position. The pit would then have been filled to hold the post in place. The wood and roofing shingles may have been deposited when the post was set or after it was extracted. If these shingles were deposited when the post was set, then the post may have been put in place as part of modification of the 1910 Hangar for the 1924 Dayton Air Show. Renovations to the hangar structure at this time undoubtedly involved refurbishment of the roof. If the shingles were introduced into the postmold when the post was extracted, then they represent disruption to this feature by the hangar demolition in the early 1940s, and they do not bear at all on the date of the post's construction. It is also conceivable that the pit and postmold are functionally unrelated, with the superpositioning being coincidental.

Posthole Patterns of the 1910 Hangar

Prior to interpreting the features identified in the 1994 excavations, it is useful to summarize details of hangar construction, and to infer how these may be manifested in the archaeological record. Fortunately, the hangar is well-documented by photographs. The 1924 Air Photo (Butler et al. 1994:4) indicates that the long axis of the 1910 hangar was oriented approximately north-south. A series of other (non-aerial) photographs (Brown 1993) show the hangar in use (Plate 1), abandoned and in disrepair prior to remodeling (Plates 6 and 7), the remodeled hangar being used as an exhibit at the 1924 Dayton Air Show (Plate 9), and the remodeled hangar at some time soon after the Air Show (Plate 10). The exact dates of these photos are not known, but they can be placed in a relative chronological sequence based on condition and use of the hangar.

An analysis of the photos (Brown 1993) suggested that, (contrary to written records), the hangar measured approximately 21 by 15 m., with a 4.25 m. eave height, and a 6 m. ridge height (Butler et al. 1994:1). Two views inside the hangar show that the building framework included five timber trusses supported by 10 cm. (4 by 4 inch) or 15 cm. (6 by 6 inch) wall posts. These major load-bearing columns were presumably sunk rather deeply into the ground. On each side of the main (south) entrance, three substantial vertical posts supported a horizontal framework upon which the large sliding doors were mounted. Most (possibly all) of these vertical door assembly posts were supported by diagonal beams (oriented at an angle of approximately 35 degrees), the bases of which were set onto or into the ground north of the door.

The hangar was originally constructed with a wood floor. No concrete slab or other prepared subfloor surface was used. The floor presumably consisted of floor boards affixed to joists which in turn set atop horizontal wooden members. As the ground surface was not completely level, these horizontal members appear to have been leveled using blocks, short sections of timber, or (conceivably) posts.

In 1924 the hangar was remodeled in preparation for use as an exhibit at the Dayton International Air Races (Walker and Wickam 1986:72). The floor boards and joists were removed and vertical posts were installed to support each truss along or near the central long axis of the hangar. These centerline posts may have been set into the ground or may simply have been wedged into place with their bases sitting on the bare dirt floor. The walls and roof were extensively refurbished, the sliding door support assembly was (or already had been) removed, the large doors were secured in a closed position, and standard size personnel doors were cut at each corner of the south wall, through the closed aircraft doors. Electric lighting was also installed. A fence was built along the east and west walls, approximately 2 to 3 m. from the hangar. The wood fence posts appear to have been rough cut and variable in diameter. The post at the southwest corner was clearly larger than the others visible in the 1924 photo (Brown 1993). It is unclear if this fence also enclosed the rear (north end) of the hangar. In a photo showing the hangar open as an exhibit in 1924 (Walker and Wickam 1986:76), both small doors at the south end are marked "entrance". It may be that visitors exited through the north end, so that if a fence was present there, a gate would have been necessary. Finally, a small ticket booth, which appears to measure about 1.5 by 2.5 meters, was built immediately in front of the south end of the hangar. It is unclear from the photograph whether the corner posts of the booth were actually set into the ground. Photos of the abandoned hangar, apparently dating some time after the 1924 exhibition, show that the ticket booth and (apparently) the wood fence posts had been entirely removed.

Archaeological manifestations of the hangar are expected to consist primarily of in situ wooden posts set in postholes, soil stains associated with filled-in post support holes and postmolds, as well as artifacts derived from activities performed at the hangar (e.g., airplane parts) and the hangar itself (e.g., nails, window and door hardware). Note that some (conceivably all) of the original door and window hardware may have been replaced during the 1924 remodeling. It may be necessary, in future studies, to attempt to differentiate between hardware installed in 1910 and 1924.

It is difficult to predict the exact dimensions of hangar postholes. The major (truss supporting) wall posts were 10 to 15 cm. on a side. The hole dug to support these posts would have been somewhat larger, with the horizontal dimensions depending on the depth and whether a shovel or posthole digger was used. These load-bearing posts were probably set at least 50 cm. into the ground (possibly much deeper), and one would suspect that a hole dug to that depth with a shovel would have a diameter of at least 30 cm. The posts supporting the sliding door framework appear to have been comparable in size, and one would expect similar postholes. It is likely the diagonal support beams were either wedged against the ground surface or set into very shallow holes. Posts which may have been set to support the joists or floor boards would probably have smaller diameters and would not have been set very deep. The disturbance of the ground surface which is believed to be associated with hangar demolition would probably have destroyed traces of many of the minor (shallow) postholes. Postholes associated with the major posts which supported the trusses and rolling door assembly should be present as relatively dark soil stains larger than 10 or 15 cm. in

diameter protruding into the clay loam subsoil. As posthole fills and surrounding soil matrices are similar in color on that part of the 1910 Hangar locus investigated in 1994, definition of postholes as features will depend on distinction of differences in soil texture and compaction. Preservation of the lowermost portions of the actual wood posts should depend on soil chemistry.

The horizontal distribution of the major postholes can be inferred with some confidence, assuming that the reported overall dimensions of the hangar (21 by 15 m.) are accurate. Figure 16 provides a schematic plan of the hangar, showing the relative position of probable and possible postholes. The locations of possible minor postholes, such as those related to floor supports, are not shown, as these would be quite speculative.

The hypothetical hangar plan (Figure 16) provides a basis for interpreting the three features identified in the 1994 excavations. Feature 1 is a definite in situ post, similar in size to a standard fence post. Feature 2 may represent a support hole for a similar post, but could conceivably also represent some other type of feature. Given that Feature 2 was identified at only 5 cm below surface, it is possible that it post-dates the time of hangar demolition. Alternatively, it is conceivable that the disturbed soil stratum is discontinuous, with Feature 2 being located within a minimally disturbed area. Feature 4 is something of an enigma. It includes a relatively-large shallow pit full of hangar construction debris (wood and roofing shingles). A possible posthole, comparable in size to Features 1 and 2, was identified at the base of the Feature 4 pit. The relationship between the pit and the posthole remains unclear.

Features 1, 2, and 4 (i.e., the Feature 4 posthole) form a reasonably straight line oriented approximately 70 degrees east of north; (if one connects the west-most and east-most features, the middle feature is off-line about 20 cm to the north). The three features are not evenly spaced along this line. The distance from Feature 1 to Feature 2 is about 2.10 m., whereas the distance from Feature 2 to Feature 4 is about 3.05 m. The Feature 1 in-situ wood post is clearly oriented about 35 degrees east of north, whereas Feature 2 appears to be oriented in reference to the cardinal points. Orientation is indeterminate for Feature 4.

The orientation of the hangar relative to magnetic north (and USACERL grid north) remains uncertain. Figures presented in the CEWES geophysical survey report (Butler et al. 1994) suggest hangar orientations ranging from approximately 7 to 33 degrees east of north (Butler et al. 1994: Figures 2, 3, 21, and 24). In any case, the orientation of the axis defined by Features 1, 2, and 4 (70 degrees east of north) is not parallel or perpendicular to the axes of any of the hangar walls based on the range of orientations presented by CEWES.

An effort was made to relate Features 1, 2, and 4 to the predicted locations of hangar postholes. The locations of the excavation units and feature centerpoints were plotted onto a transparent plastic sheet. This map was then overlaid onto the schematic plot of predicted posthole locations (Figure 16). Efforts to match the three features with predicted post locations were based on spacing rather than orientation. Feature 4 was viewed as the best candidate to be a support hole for one of the major load-bearing posts. The maximum depth of the possible posthole observed at the base of the Feature 4 pit was not determined. However, the base of the pit extended to approximately 27 cm. below surface. Thus, the Feature 4 posthole could conceivably be deep enough to represent a major post support hole. Based on the position of the excavation units relative to the CEWES plot of the hangar location, it is conceivable that Feature 4 represents one of the truss support posts in the east wall, possibly the center post. However, neither of the other features (Features 1 and 2) appear to

fall near the predicted locations for any of the other major postholes. The shortest distance from the east wall to the truss posts installed down the central axis of the building in 1924 is predicted to be 7.5 meters, but the distance from Feature 1 (the west-most feature) to Feature 4 (the east-most) is only about 5 meters. Thus, if Feature 4 does represent an east wall truss support post, Features 1 and 2 presumably represent smaller posts installed to support the floor joists or floor boards. The same interpretation for Features 1 and 2 would follow if one assumes that Feature 4 represents one of the central axis supports installed in 1924. Under this interpretation, the Feature 4 shallow pit may have been dug to allow a post to be wedged into place. The shallow pit may then have been filled with whatever material was readily available, including construction debris from the remodeling.

If Feature 4 is assumed to be associated with one of the trusses supporting posts in the west wall, then Feature 2 is interpretable as one of the posts supporting the fence built in 1924 just west of the west hangar wall. Unfortunately, Feature 1 is then too far west to be associated with any part of the hangar or fences recognized in the archival photographs (Brown 1993).

If one chooses to interpret Feature 4 as a minor posthole associated with the south wall after the main doors were secured in a closed position in 1924, it is possible to relate Features 1 and 2 to the fence which was built just south of the south wall in that same year. This interpretation would place the artifacts interpreted as door and/or window hardware very near the location of the main doors. This implies that these artifacts were not significantly displaced by bulldozing. Furthermore, an assumption that Features 1, 2, and 4 are associated with the south hangar wall and the fence built just to the south of that wall in 1924 does not follow from the position of the excavation units relative to the CEWES hangar location (see Figure 6).

At present, it is not productive to continue with inferences about which hangar posts may be represented by Features 1, 2, and 4. Additional excavations would almost certainly reveal more features. Based on the quality of preservation observed in Feature 1, it is likely that some of these would also contain preserved remains of the wood support posts. A larger sample of features should make it possible to correlate particular postholes with particular structural members of the hangar. Similarly, a much larger sample of artifacts recovered with reliable horizontal provenience should make it possible to determine the nature of hangar demolition.

In summary, the relatively small-scale excavations conducted by USACERL in 1994 demonstrated that artifacts clearly associated with the hangar, and in-the-ground features which are very probably associated with that building are present within the area where the CEWES remote sensing study (Butler et al. 1994) detected anomalies. Large-scale controlled excavations would almost certainly recover data that would contribute significantly to a historically accurate replication of the 1910 Wright brothers hangar.

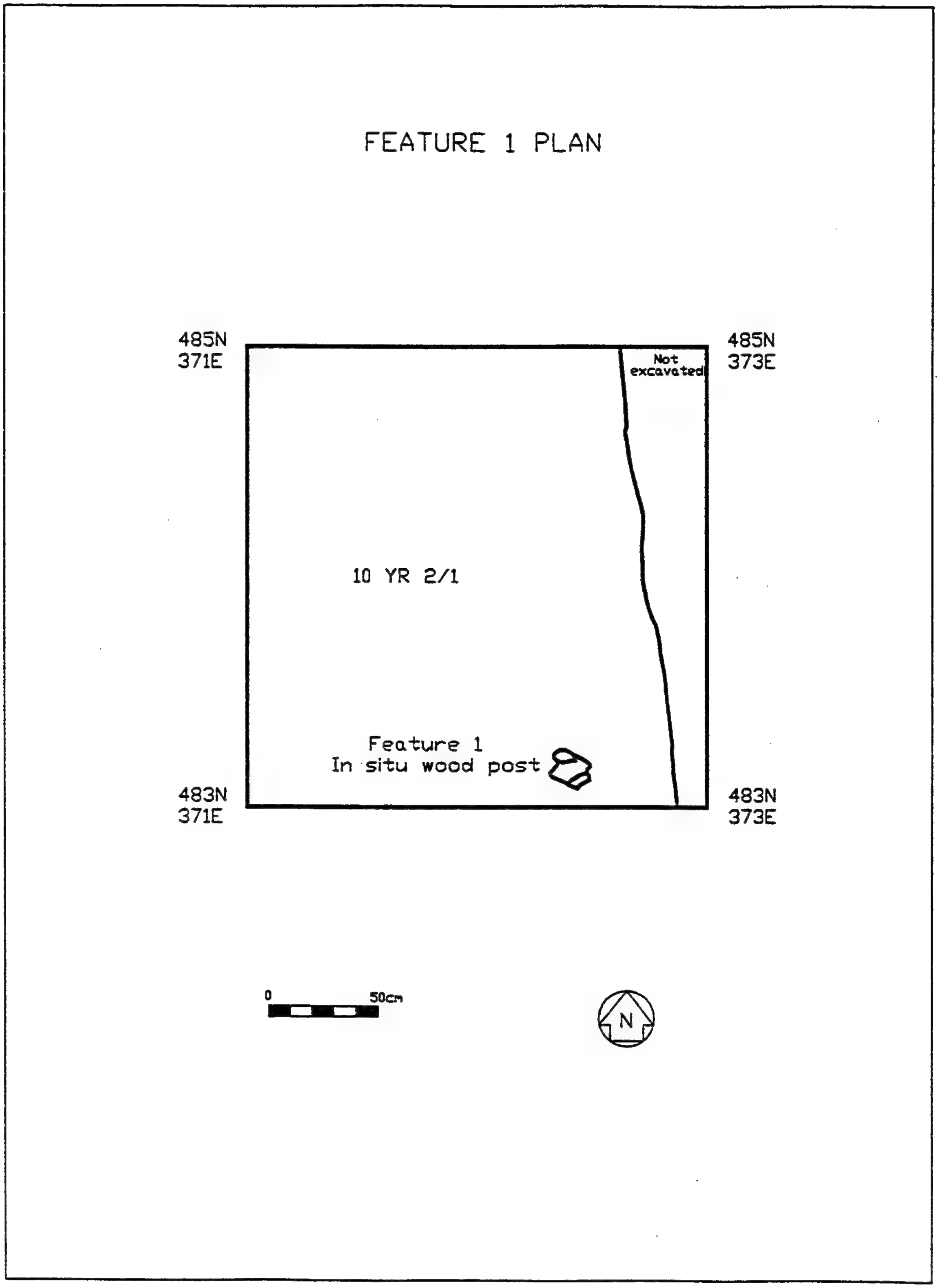

Figure 7. Plan View of Feature 1 in Unit 483N/371E

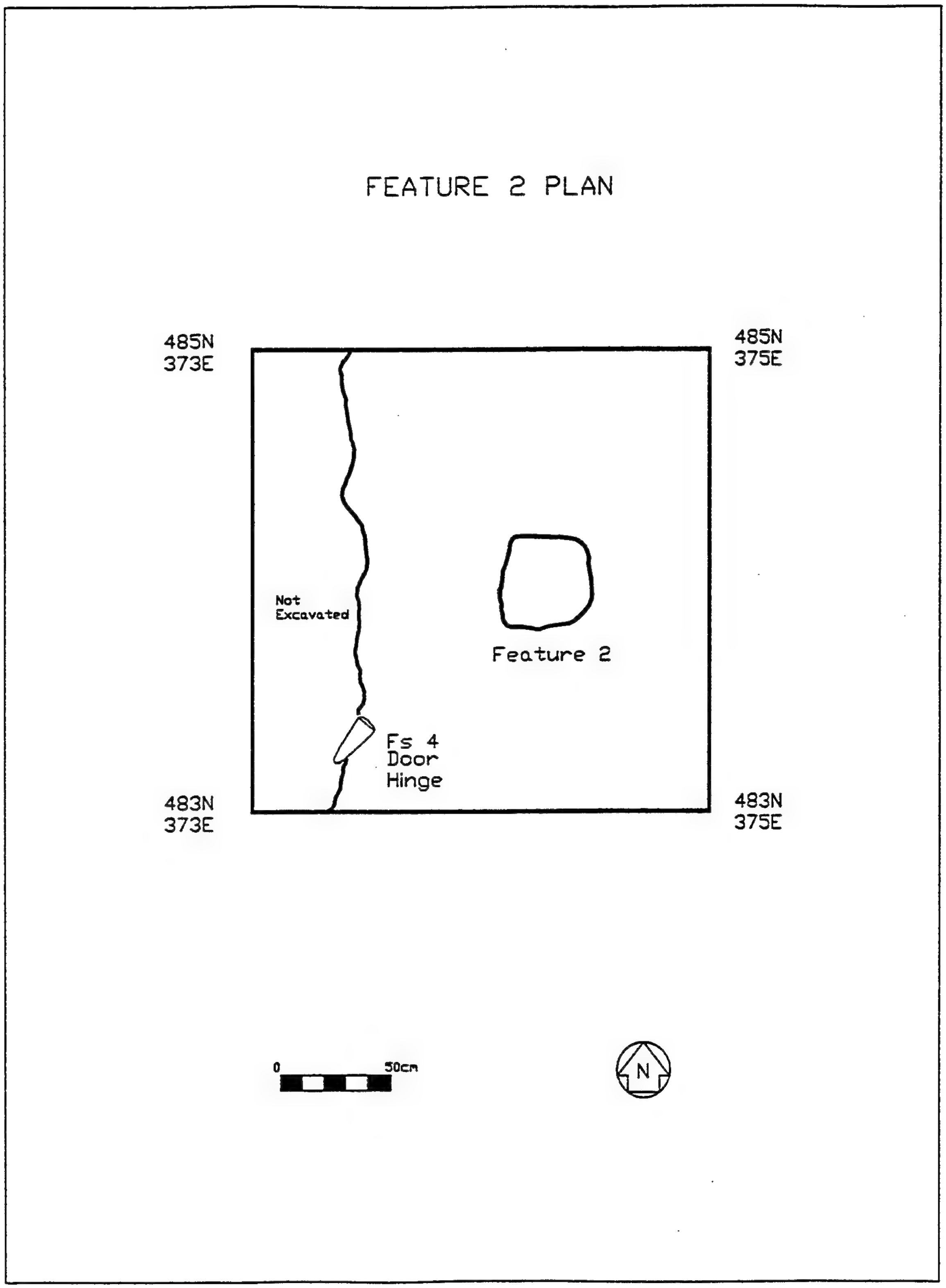

Figure 8. Plan View of Feature 2 and Large Iron Strap Hinge in Unit 483N/373E

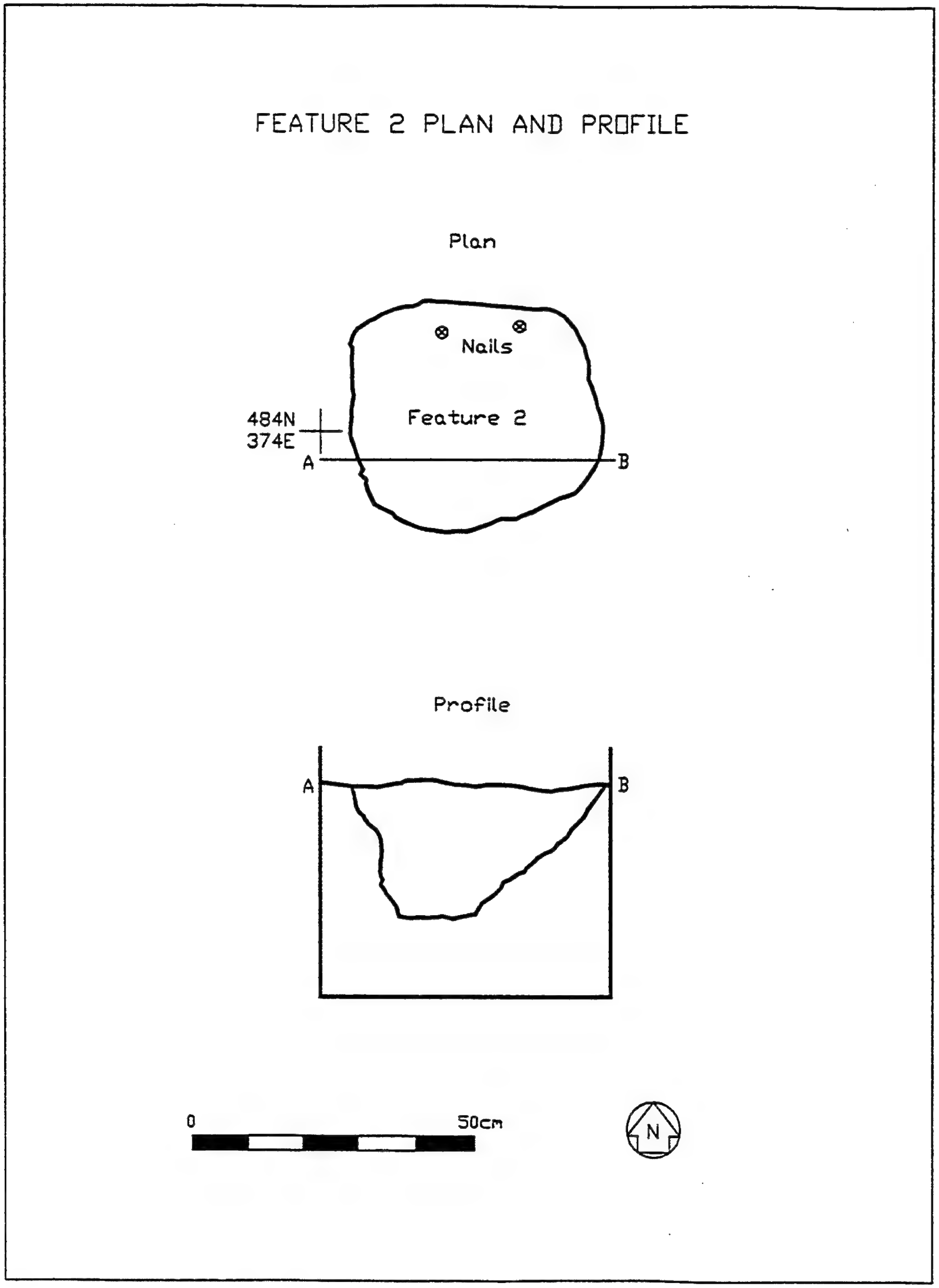

Figure 9. Plan and Profile of Feature 2

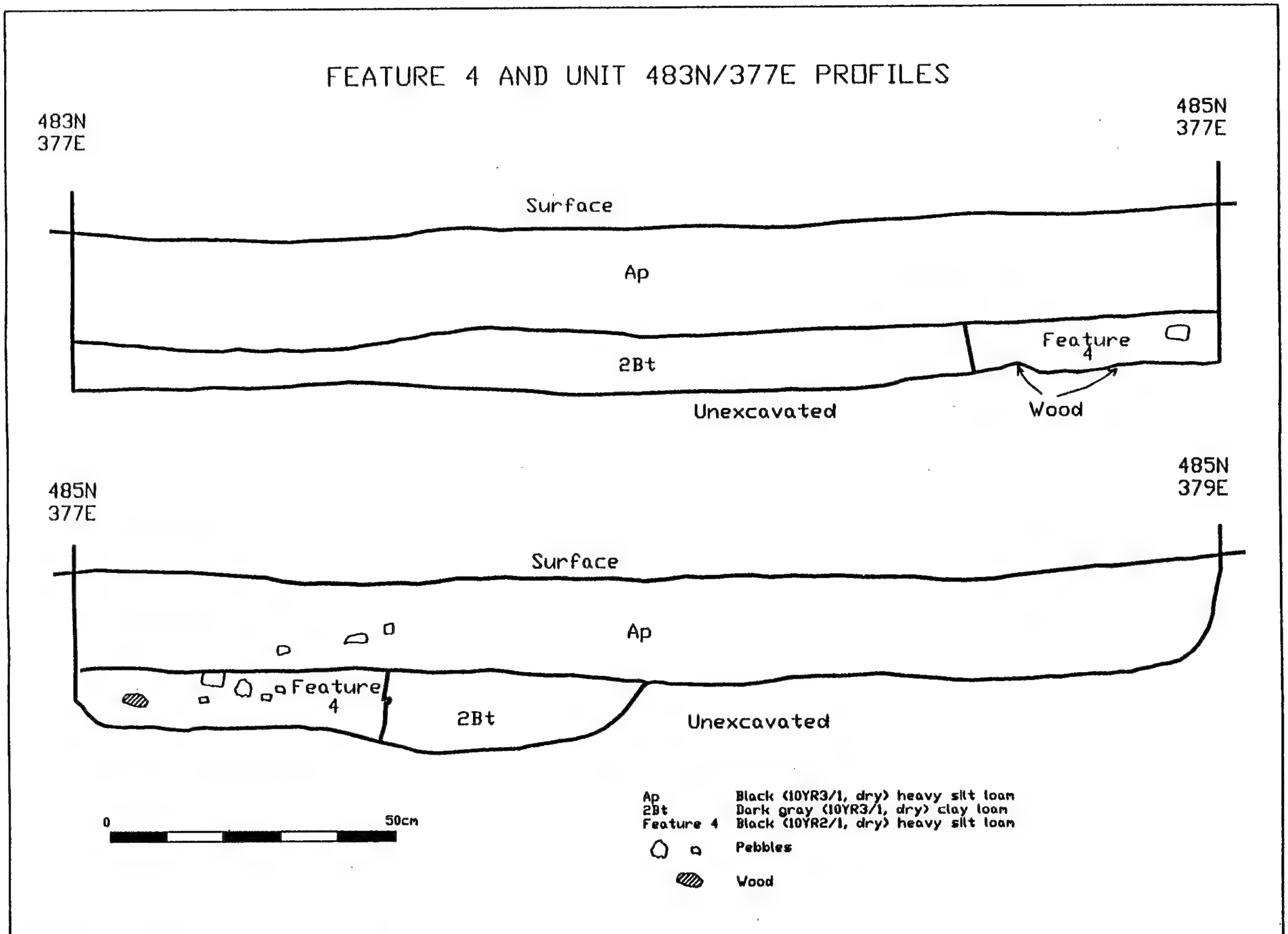

Figure 10. Unit 483N/377E Wall Profiles

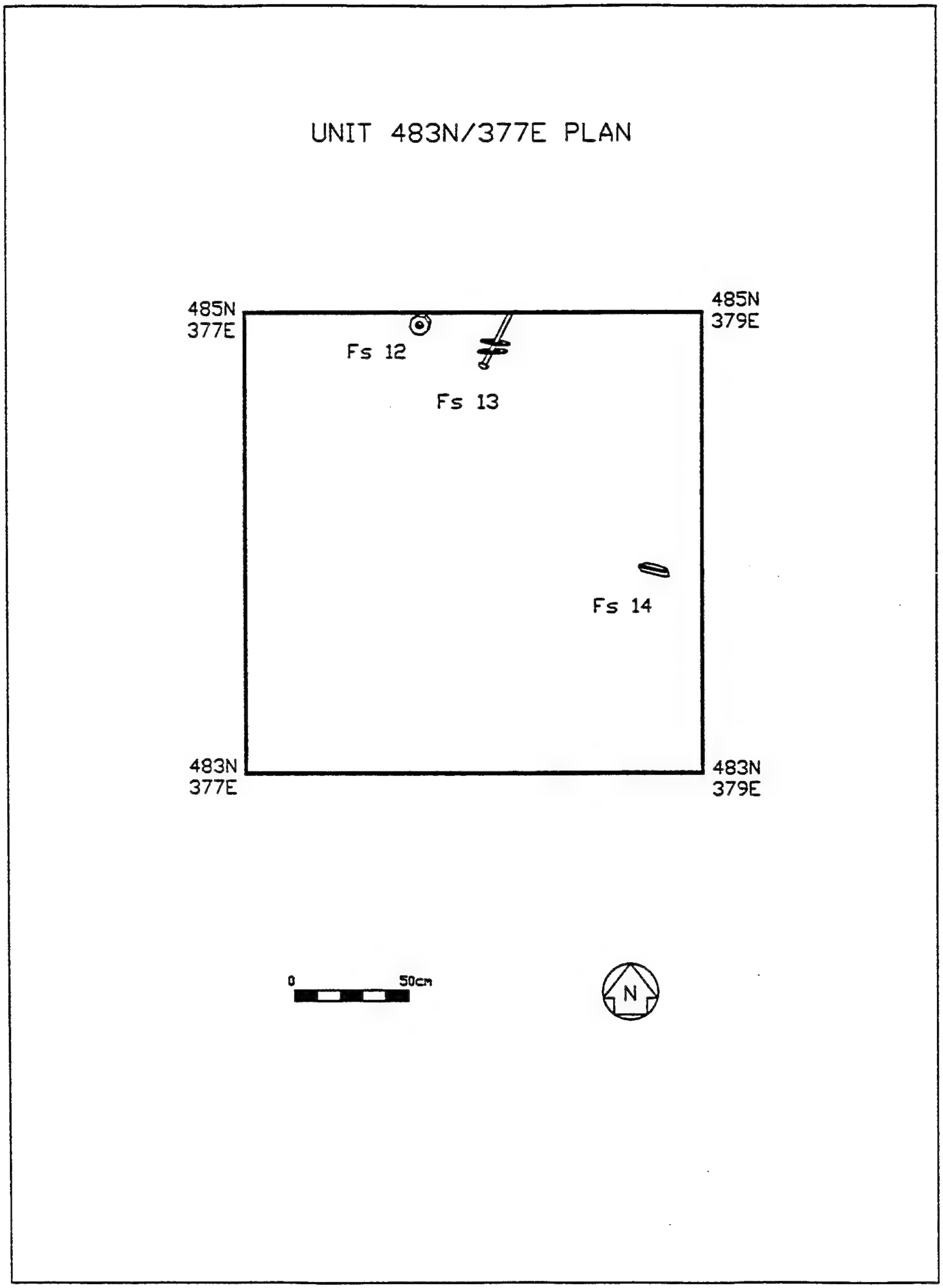

Figure 11. Plan View of Unit 483N/377E

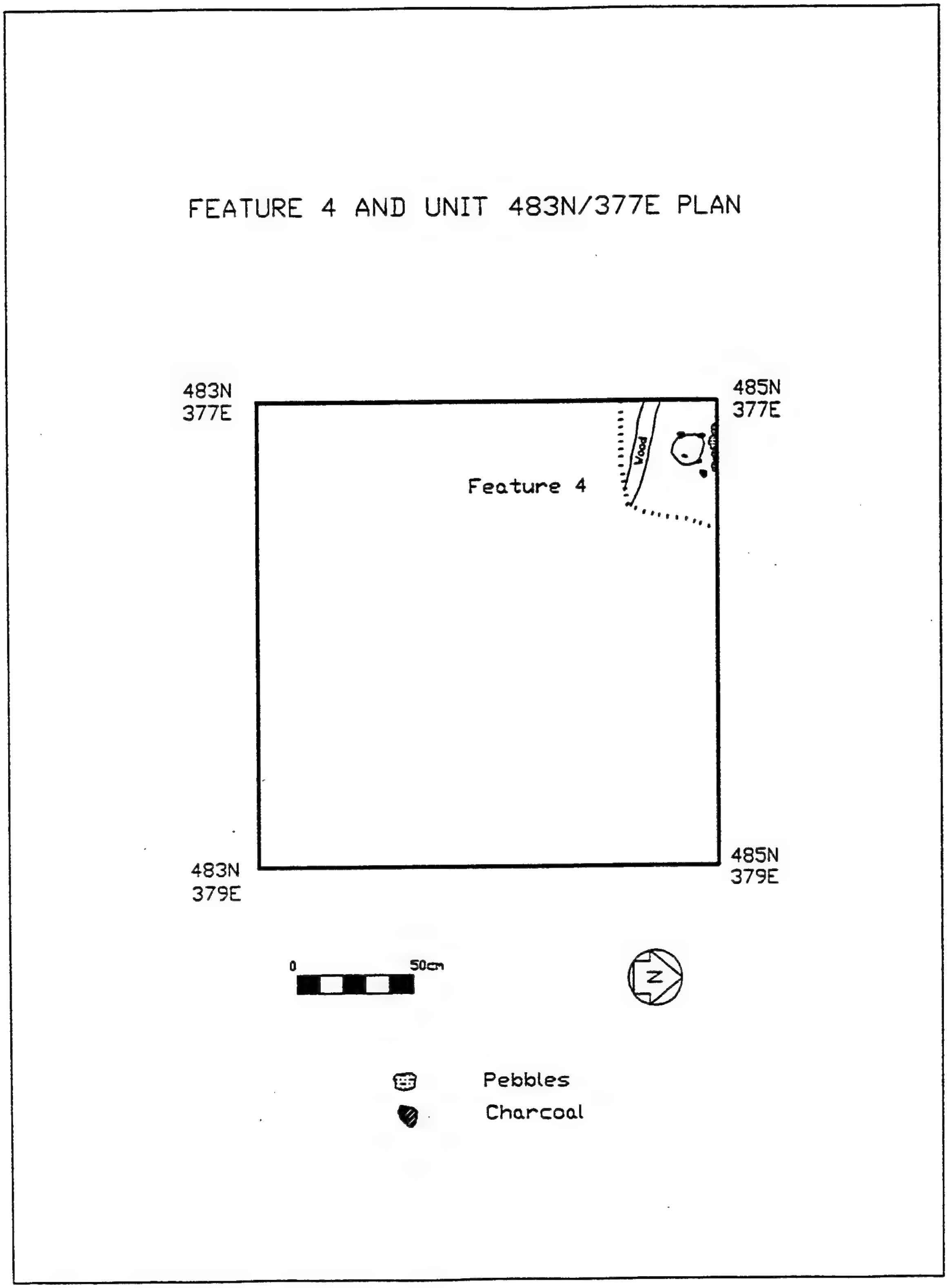

Figure 12. Plan View of Feature 4 in Unit 483N/377E

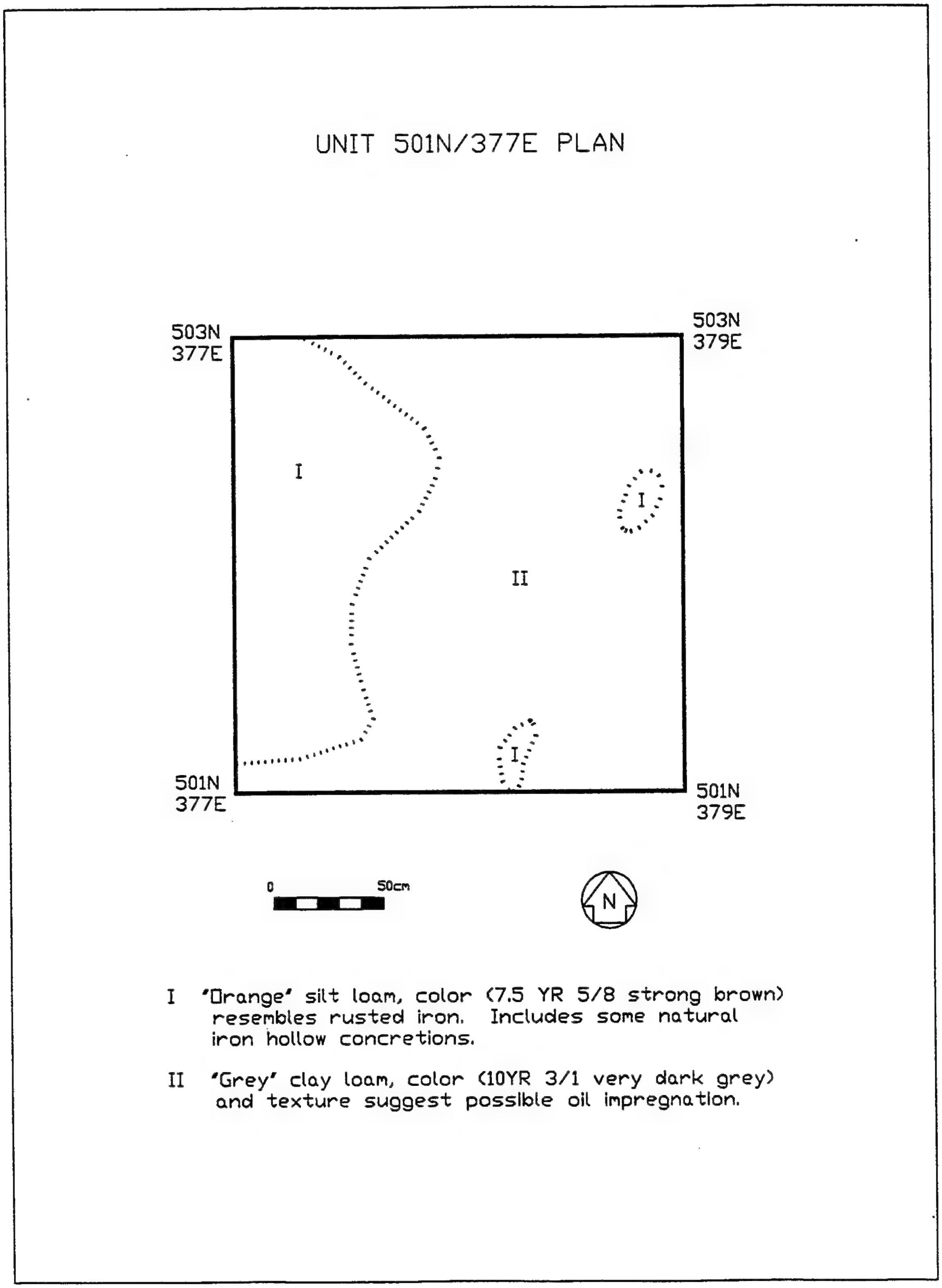

Figure 13. Plan View of Unit 501N/377E at 20 cm. Below Surface

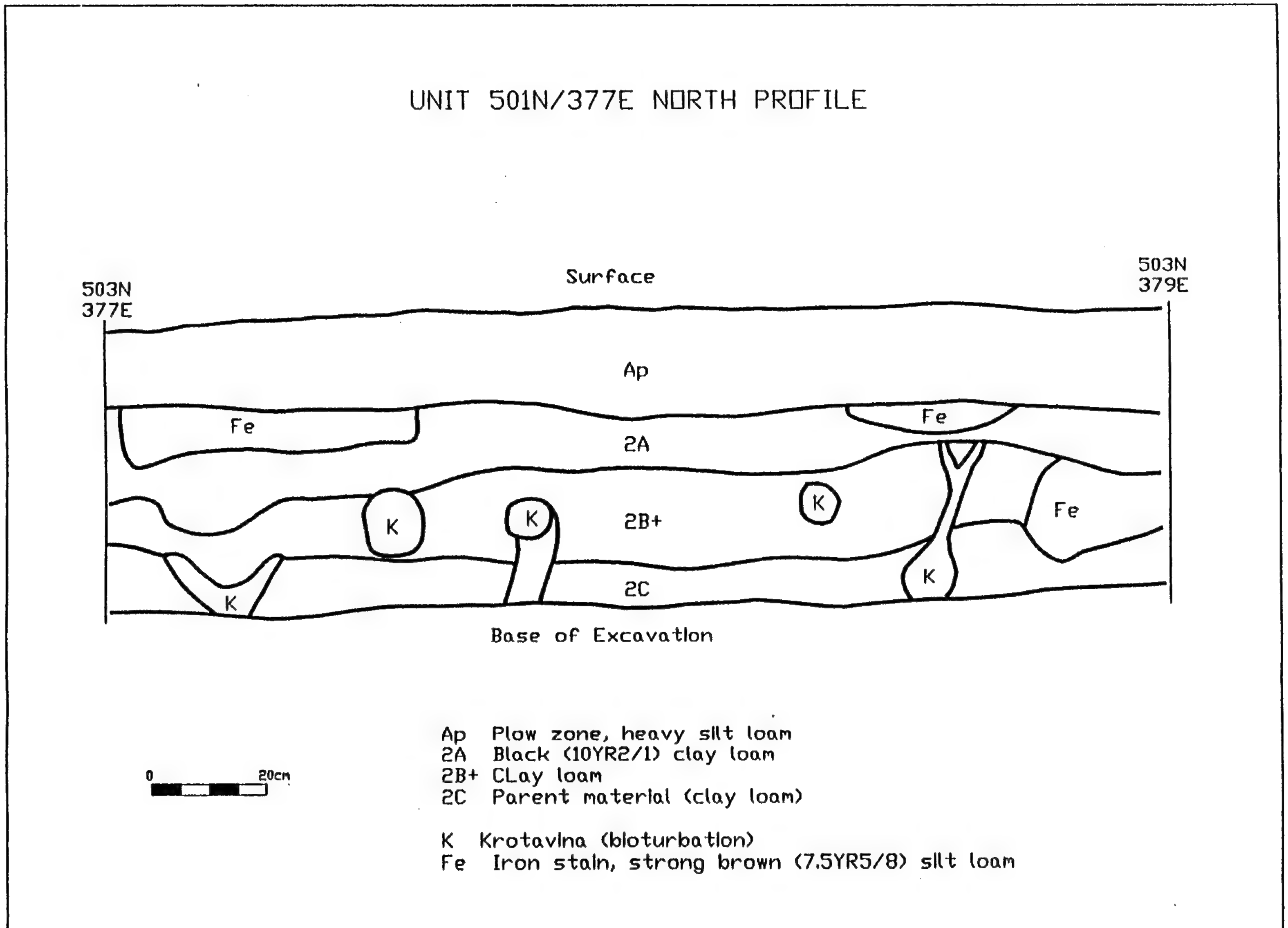

Figure 14. Unit 501N/377E Wall Profile

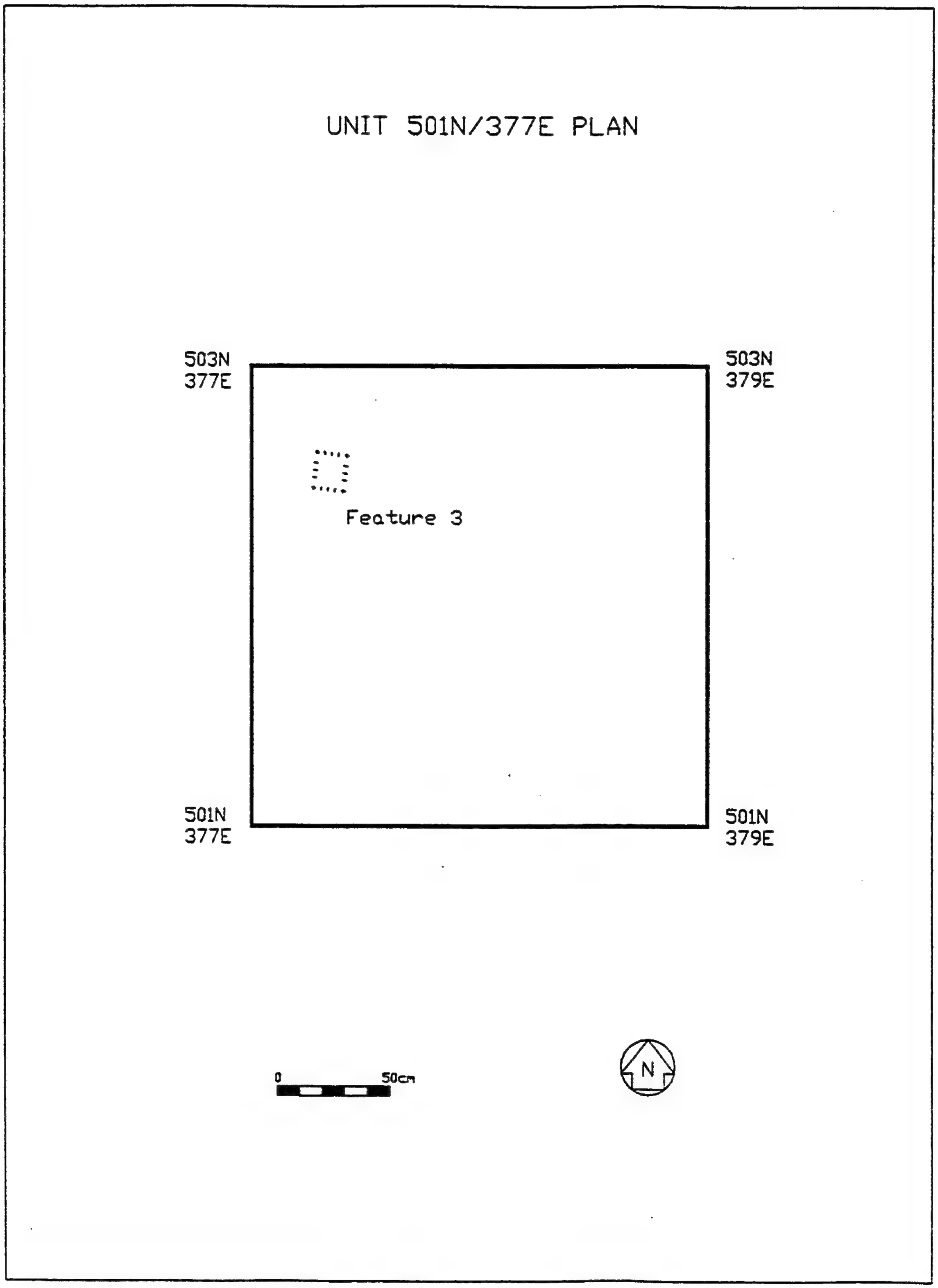

Figure 15. Plan View of Feature 3 in Unit 501N/377E

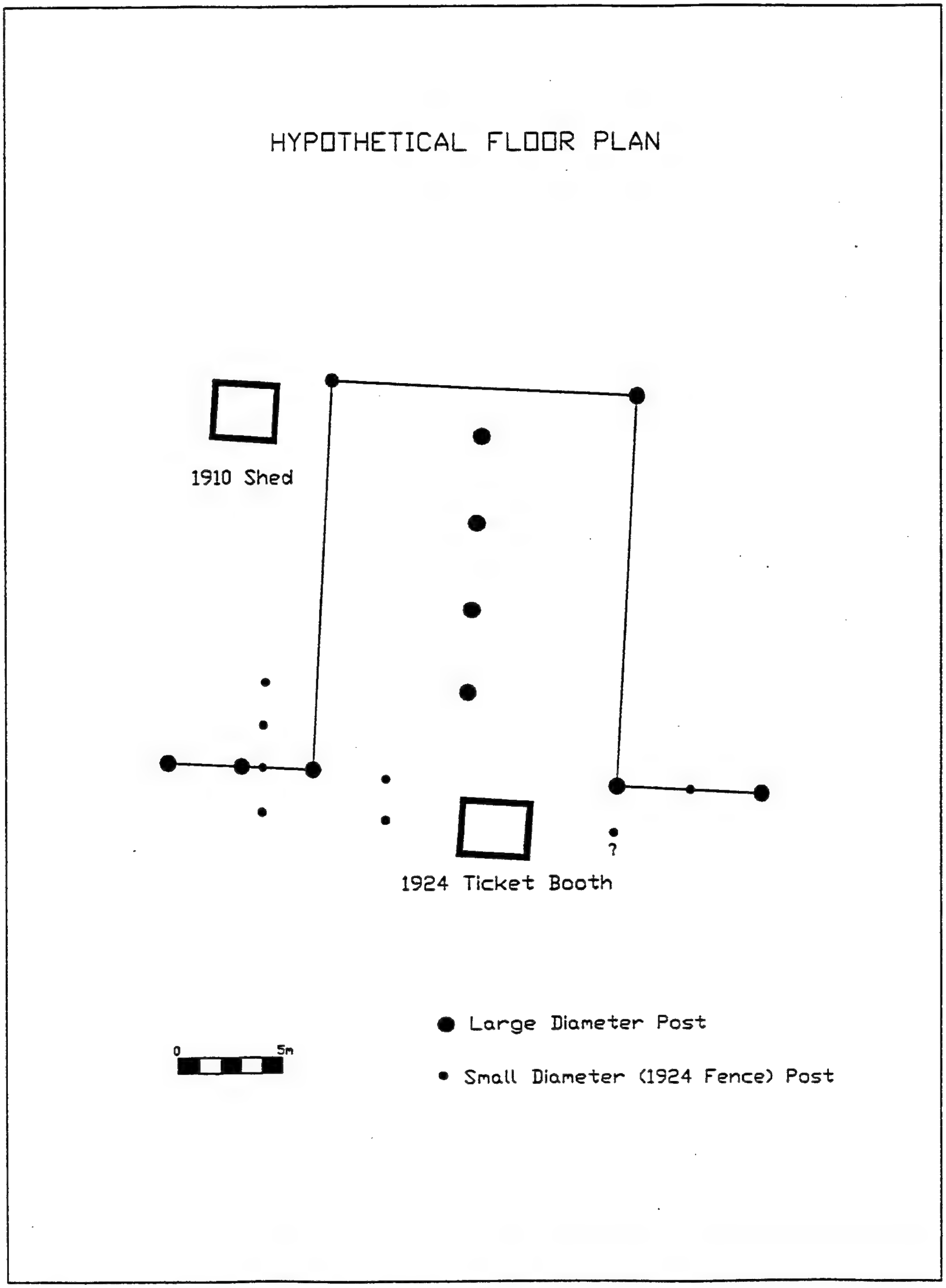

Figure 16. Hypothesized Location of Major and Smaller Posts

Chapter 7
ARTIFACT ANALYSES

1990 Artifact Analysis

The 1990 excavation units were distributed nonrandomly across the hangar locus. A block of seven 1 by 1 m. units was excavated to investigate an apparent concentration of artifacts in the vicinity of 500N/387E. This concentration is thought to reflect the consolidation of debris after the hangar was demolished. Overall, artifact distributions suggest that the 1910 Hangar locus is bounded on the north by the 520N line, on the east by the 405E line, on the south by the 475N line, and on the west by the 370E line.

The 1990 excavations recovered 4,171 artifacts (Table 1). Several general classes of materials are represented in this collection. Numerous bullets, shell casings, and shotgun-shell cases or bases probably relate to use of near-by areas as a shooting range by WPAFB . Also notable in the 1990 assemblage are numerous pieces of asphalt shingles with red flecks on the outer surface.

Flat (window) glass was found in relatively great abundance in the 1990 units. The 1,750 pieces of flat glass comprise 42% of the total artifact collection (Table 1). The glass is derived from the windows in the gable ends of 1910 Hangar, as shown by the post-abandonment photographs (Brown 1993). The incidence (42%) of window glass vastly exceeds its expected occurrence on domestic sites (South 1977:88-106), and reflects the industrial, or special-use, nature of the hangar locus. Most of the flat glass occurs immediately north of the hangar footprint (Figure 17).

Flat glass is also significant in that it is the only datable artifact found in sufficient quantities to give an independent date for the hangar locus. The hangar's solidly-documented construction in 1910 and use through 1916, however, means that the glass analysis is more a way of testing the dating method (Roneke 1978) than of providing a date for the 1910 Hangar locus. The flat glass dating method used in this analysis was developed by Karl G. Roneke (1978), and refined by Charles E. Orser, Jr. (personal communication) for sites in the southeastern United States. The method is based on Roneke's (1978) observation that window glass thickness increased through the 19th century, allowing dates and date ranges to be estimated based on the thickness of glass in an artifact assemblage (Table 1). This method did not work for the 1910 Hangar collection. The dates estimated from the flat glass thicknesses run fifteen to twenty years early, throughout the collection. The general collection date, 1897, is thirteen years before the hangar's documented construction date of 1910. The dates based on glass also fail to agree with the only other datable artifact found on the site, a 1910 Lincoln-Head penny from Unit 490N/387E.

It may simply be that the Wright Aeronautical Company (or their contractor) used old window glass in building the 1910 Hangar. It may also be that the thickness distribution of flat glass sherds from the 1910 Hangar locus was affected by replacement of the original (1910) windows for the Dayton Air Show in 1924. Such replacement would be expected to produce a bi-modal distribution, with thickness-class clusters around the date of original construction, and the date of window replacement. Such a bi-modal distribution was not observed in the 1990 collection from the 1910 Hangar locus (Table 1). This distribution could not, in any case, explain why the flat glass date from the 1990 collection runs earlier than the documented construction date of 1910. Replacement of the windows fourteen years after the hangar's construction should skew the date later, not earlier. It is

possible that these glass thickness date ranges, derived from assemblages from the Southeast, do not work well in the Midwest. It is also possible that this method works best in the early-to-middle 19th century, and that window glass thicknesses tended to "plateau" (that is, to stop increasing) after 1890 or 1900. These questions can only be solved by further research employing flat glass collections at other midwestern sites.

Iron nails represent a second major category of architectural artifacts found at the 1910 Hangar locus. Many of these nails were too rusted or incomplete to categorize, but all of those which could be positively identified were wire (round) nails, manufactured after 1890 (Nelson 1968). This observation agrees well with the hangar's 1910 construction date. The distribution of iron nails (Table 1) corresponds to the overall distribution of artifacts on the 1910 Hangar locus, with a concentration near 495N/380E (Figure 18). Along with window glass, the distribution of these nails gives the strongest evidence that the 1910 Hangar was located in this area (or, at least, that most of the debris ended up here after the hangar was demolished). Of greatest significance, however, is the large number of nails (N=1,212) found on the site. Nails constitute 29% of the 4,171 artifacts collected in 1990. Nails and window glass together comprise 71% of the total collection. This points out the clear dominance of architectural artifacts in the 1910 Hangar assemblage, a dominance which would only be increased by adding in other architectural artifacts (most notably, fragments of asphalt roof shingles). Such an assemblage is expected for an industrial site, but differs dramatically from the domestic sites more often studied by historical archaeologists (South 1977).

Domestic artifacts such as ceramics and container glass are not abundant at the 1910 Hangar locus. At 110 artifacts, these categories make up only 3% of the 1990 collection (Table 1). There are only two pieces of ceramics in the assemblage, one sherd of plain porcelain from Unit 495N/394E and one sherd of plain whiteware from Unit 498N/500E. The remaining 108 domestic artifacts are sherds of curved glass, largely from bottles, though a few are from jars, lamps or other glass vessels. The one datable glass sherd is an improved-tool, wax-seal canning jar rim ranging from 1875 to 1915 (Jones and Sullivan 1985). Again, the paucity of domestic artifacts at the 1910 Hangar locus shows the industrial character of this site. The preponderance of bottle sherds among the domestic artifacts shows a simple pattern of behavior, one that is still observed in factories and other work places. Workers (in this case, aircraft mechanics, pilots and pilot trainees) were consuming bottled soft drinks for refreshment while they worked or when they took breaks. Most of the domestic artifacts occur within the main artifact concentration immediately north of the hangar footprint (Figure 19).

Of particular significance are the industrial or "special purpose" artifacts that indicate the hangar's function (Table 1). Notable here are the metal parts from Wright Flyer aircraft found on the site. These items include an aluminum control wire guide from Unit 495N/387E (Plate 11) two iron turnbuckles for tightening wing struts from Unit 500N/385E (Plate 12), and large "bicycle" drive-chain links from Units 498N/386E, 498N/388E, 499N/387E and 500N/372E (Plate 13). These drive-chain links are a very specific indication of the presence of Wright aircraft at the 1910 Hangar site. Such drive chains transmitted power from the engine to the propellers on these early airplanes (Lippincott 1987:80-81), but were used on few other aircraft. Other machine parts and industrial artifacts, including some possible airplane parts, are listed in Table 1.

Industrial artifacts number 82, 2% of the total collection of 4,171 artifacts at the 1910 Hangar locus. This percentage is somewhat inflated by the relatively-large number of industrial artifacts found in Units 500N/372E and 500N/373E, where two fragmented iron tubes were recovered (Figure

20). The greatest significance of these industrial artifacts is the evidence they provide for presence of Wright aircraft at the 1910 Hangar, and for the repair and maintenance of these airplanes. These artifacts may also have some significance as objects for display and public education, at the Huffman Prairie Flying Field site, the Air Force Museum on WPAFB, or at a visitor center for the Dayton Aviation Heritage National Historical Park.

In sum, the analysis of the 1990 artifact collection from the 1910 Hangar locus accomplishes several things: (1) It establishes the location of the 1910 Hangar (or, at least, the location of the majority of the debris from this building), very close to where this structure was placed by historical documents, by living witnesses (in 1941), and by the geophysical survey. (2) The preponderance of architectural artifacts (71% of the total collection) establishes the general character of the 1910 Hangar locus as an industrial site, and suggests that the majority of the artifacts present on the site come from the hangar structure. (3) The analysis establishes the purpose and function of the site, independent of any historical documents, as a facility for the storage, repair and operation of early aircraft. (4) The artifact analysis also demonstrates that this collection contains items from early aircraft manufactured by the Wright Aeronautical Company if not by the Wright brothers themselves, artifacts which may have display and educational value.

1994 Artifact Analysis

The purpose of the 1994 excavations was to locate remains of the actual hangar structure, not to recover additional artifacts. Analysis of the 1994 artifact collection therefore emphasizes artifact function, with the goal of identifying the nature and function of architectural remains of the hangar. Unless specified otherwise, figures showing artifact distributions (Figures 17-21) combine 1990 and 1994 data.

The composition of the 1994 collection is very similar to that of the 1990 assemblage (see preceding section). In both collections, domestic artifacts (ceramics, bottle/vessel glass, utensils, etc.) are not strongly represented, reflecting the industrial, single-function character of the hangar facility. Nails, window glass, and fragments of asphalt roofing make up most of the collection. Airplane parts represent a tiny but very interesting portion of the 1994 hangar assemblage.

Four definite airplane parts were found at the 1910 Hangar locus in 1994. Three of these parts were recovered from one shovel test and probably fit together as an assembly. These three artifacts were found in Shovel Test 1 (493.N/405.00E), slightly east of the hangar location as identified by the CEWES geophysical survey (Butler et al. 1994). All three artifacts are pieces of iron (probably, steel) plate. One piece is flat and two are L-shaped. Assembled with the flat piece on the bottom and the two L-shaped pieces at right angles, these three artifacts form a U-shaped strut support or fastener. They are similar to supports/fasteners on the base of the propeller support strut on the Wright Flyer Model B that is displayed in the United States Air Force Museum at WPAFB .

The other definite airplane part is a piece of iron (probably, steel) power-transmission chain. This item was found in Level 2 (10-20 cm. below surface) of test unit 501N/377E. As with Shovel Test 1, this unit is outside the limits of the hangar as located by the geophysical survey (Butler et al. 1994). This chain side plate, with rounded ends and two bolt holes (one of which has been broken out by corrosion), is very similar to several pieces of airplane power transmission chain found during the 1990 project.

One artifact represents a possible airplane part or, at least, an artifact that may be associated with aircraft operations. This is a torpedo-shaped iron (probably, steel, and with a possible lead core) weight. It is very similar to a window sash weight in its size and shape. This weight may have been used to balance an aircraft for flight. The item may also have been part of the hangar structure, even a window sash weight, as suggested by its shape. However, no sashed windows are seen on the 1910 Hangar in a series of photographs (Brown 1993) taken during and after its use.

The overwhelming majority of the artifacts found in 1994 represent construction materials related to the 1910 Hangar. These materials include 90 sherds of window glass, representing 3.5% of the 1994 artifact collection. This low percentage of glass contrasts with the 1990 assemblage, within which window glass accounts for 42% of the total. This difference probably reflects the distribution of artifacts within the 1910 Hangar locus, as well as the different excavation strategies followed in 1990 and 1994. The 1990 excavations focused on the area north and east of the inferred hangar location (see Figure 6, page 29). The disproportionate amount of window glass in this area may result from movement of debris during hangar refurbishment or demolition, or through vandalism of the north windows while the hangar was standing. Four of the 1994 units were located in the east-central part of the hangar footprint (Figure 6), as projected by the CEWES geophysical survey (Butler et al. 1994). The same processes cited above as producing the high concentration of window glass in the 1990 trenches may have moved window glass away from the 1994 test unit locations.

Among the 903 nails recovered in 1994 are many wide-head roofing nails. Nails represent 35% of the 1994 collection, and this is roughly comparable to the 1990 assemblage, where nails account for 29% of the total. Figures 17 and 18 show that both flat glass and nails are concentrated at the north end of the hangar footprint, but that nails have a much wider distribution throughout the footprint area. This distribution reflects a site-formation process which moved window glass (and some nails) away from the 1910 Hangar footprint but left some nails closer to their original position in the hangar structure. The movement of debris by a bulldozer during demolition could not result in this kind of sorting. The nails and window glass would move together in the mass of debris and humus, and would be deposited in the same places. Thus, pre-demolition movement of window glass away from the structure (by vandalism or localized discard of replaced windows) is suggested. This pre-demolition process does not preclude a generalized movement of debris during demolition. But the distribution of glass suggests that the movement of debris was not so extensive as to destroy the integrity of pre-demolition patterns of artifact distribution at the 1910 Hangar locus.

Demolition or remodeling processes are also reflected in the characteristics of some artifacts found in 1994. A few (167 artifacts; 6.5% of the collection) of the architectural artifacts exhibit evidence of burning, (melted glass, carbonized nails, melted and fused asphalt shingles). This probably reflects burning of scrap lumber and other debris during the 1924 remodeling, and/or burning of debris after demolition. Charcoal and charred fragments of lumber are also present in the collection, indicating the same process. The low percentage of burned artifacts may suggest that all the debris from the hangar was not burned at the time of demolition.

Notable artifacts recovered in 1994 include a large bolt and washer or roller assembly, a large washer, and a second large carriage bolt, all found about 20 cm. below surface in unit 483N/377E. These items probably served to attach major components of the hangar frame to major structural members, such as corner posts or roof/rafter plates. The bolts and washers may also represent

components of the roller door assembly found on the south side of the hangar, serving as supports or axles for the rollers, or holding together parts of the roller track or roller trestle.

Also related to the hangar is a very large iron strap hinge, recovered at approximately 20 cm. below surface within unit 483N/373E (Plate 14). This large, tapered hinge measures 21 cm. from butt to rounded point and 8.0 cm. across at the actual hinge, and has four fastener holes arranged in zig-zag pattern across each strap. Traces of a grey substance, probably paint, can be seen on the surface of one strap. This hinge is typical of the plain, undecorated strap hinges often used on barn doors, industrial buildings, or gates. The hinge appears identical to the four hinges shown on the two personnel doors added to the main (rolling) doors on the south side of the hangar during remodeling for the 1924 Dayton Air Show (Plates 9 and 10), as seen in photographs during and after that show (Brown 1993).

A piece of lumber with an angled saw cut, found in Machine Trench 4, also represents the hangar's structural fabric. This cut describes an angle of approximately 35 degrees across the prevailing grain of the piece, indicating lumber cut to fit as part of the hangar structure.

The recovery of construction materials associated with the hangar in units 483N/371E, 483N/373E, 483N/377E and 483N/381E indicates presence there of a major and complex part of the hangar structure. These items may represent in situ remains of a collapsed portion of the hangar, or they may have ended up here as a result of movement of debris during demolition. The second explanation is more likely, given the association of the strap hinge with the southern wall of the hangar, and its recovery from the disturbed level in unit 483N/373E, which falls within the east-central part of the hangar footprint. If the south wall was pushed inward (from the south) then hardware attached to the wall could easily have ended up in the area of units 483N/371E, 483N/373E, 483N/377E and 483N/381E. Features 1, 2 and 4 were also found in these units, below the disturbed zone that contained these structural artifacts. These features demonstrate the persistence of in-situ archaeological remains within the hangar footprint, below the zone of disturbance created by demolition of the hangar structure. Recovery of a number of large artifacts at 20 cm below surface (i.e., at the base of the disturbed stratum) may be a result of moldboard plowing, which turned under debris left on the surface after hangar demolition.

At first glance, the distribution of airplane parts does not appear to be coterminous with the concentration of construction materials. However, the apparent concentration of airplane parts off the northwest corner of the hangar footprint is misleading (Figure 20), resulting from two tube-like artifacts having broken into numerous pieces. There is some basis for expecting a segregation of activity areas within the site. Historic photographs (Brown 1993) indicate that, the 1910 Hangar was virtually windowless, having only four small windows high up in each gable end and some windows in its rear (north) wall. There probably was not sufficient natural light within the hangar to work on airplanes unless the main doors were open. The question of artificial light in the building during its use from 1910 to 1916 is unresolved. There are a few pieces of lamp or light bulb glass in the 1994 collection (see Appendix B). Brown (1993) states that electric power was added to the building during remodeling for the 1924 Air Show, and these sherds of possible light bulb glass may date to that time. It may also be that space inside the hangar was too restricted to work on the airplanes, especially if the hangar happened to contain its full complement of three aircraft (Brown 1993). It seems likely that airplanes were stored in the hangar, but serviced and repaired outside the building. In 1994, four airplane parts were recovered, all located north (501N/377E) and east (493N/405E)

of the hangar footprint. These fall within the overall artifact concentration and so may simply have been moved there at the time of hangar demolition. It is conceivable, of course, that these airplane parts were deposited there prior to demolition and thereby indicate an activity area. This possibility is best supported by the airplane parts recovered from shovel probe 1, approximately 18 m. east of the hangar footprint and well outside of the main artifact concentration.

Artifacts were recovered from the fills of two of the three features (Features 2 and 4). Feature 1, an intact post, was left in situ, and no artifacts were recovered from the fill. Most of the artifacts from Features 2 and 4 are wood fragments that may come from posts once present in these holes. Other artifacts include nails, a few sherds of window glass, and some asphalt roofing. A concentration of 70 pieces of roofing was recovered from Feature 4. It is unlikely that the nails, window glass, and asphalt shingle fragments were introduced into postholes at the time of initial hangar construction (1910). The presence of these structural artifacts in the posthole features may have resulted from building demolition. For example, posts may have been uprooted during hangar demolition, allowing artifacts to enter the disrupted postholes. Artifacts may have also been introduced into features created while debris from the hangar remodeling was present. These features would, most likely, be fence posts or other posts installed during the 1924 Dayton Air Show remodeling.

Summary

An analysis of the 1994 artifact collection and comparison with the 1990 assemblage supports several observations about the 1910 Hangar locus. The limited chronological information provided by the assemblages tends to confirm the well-documented early-20th-century date of the hangar's construction and use. The only data which contradict this conclusion pertain to the flat glass thickness dating conducted on the 1990 materials. This contradiction probably results from limitations of the analysis method, not the chronology of the artifact collection from the 1910 Hangar.

A functional analysis of the artifacts (especially the larger 1990 collection) reveals the strongly industrial nature of the 1910 Hangar locus. Overall, the hangar assemblage is dominated by architectural materials, with only minuscule percentages of the domestic artifacts which dominate farmstead, house or plantation site assemblages. The artifact assemblage reflects the short occupation and restricted nature of use of the 1910 Hangar locus. Historical records and photographs indicate that the hangar was used for less than six years to store, maintain and service Wright aircraft. The 1990 and 1994 artifact collections are entirely consistent with such use, and reveal no other uses of the hangar locus.

The 1990 investigations identified a concentration of artifacts centered just to the north of the north end of the hangar footprint (Figure 21). The most probable explanation for this concentration is that it represents the remnants of a pile of debris, consolidated in this location during demolition of the hangar.

Large structural artifacts were recovered in 1994 from the test units located along the 483N line. These artifacts appear to relate to the south wall of the hangar, i.e., the wall with the aircraft doors (Brown 1993). The presence of these artifacts in the east-central part of the CEWES hangar footprint suggests that the south wall of the hangar collapsed inward (to the north) during demolition.

The presence of architectural artifacts in the fill of Features 2 and 4 can not be explained

definitively. These artifacts may have been introduced into the postholes at the time of remodeling for the 1924 Dayton Air Show, or when the posts were uprooted at the time of demolition.

Demolition and debris consolidation appear to have disturbed as much as 20 cm. of soil, particularly within the central portion of the footprint. It is probable that actual earthmoving was minimal, involving mechanized scraping of the ground surface as debris was consolidated. The occurrence of burned artifacts suggests that some or all of the hangar debris was burned. Following burning, the hangar locus may have been plowed. This would account for the disturbance of the uppermost 20 cm of soil, and the presence of a concentration of artifacts at the very bottom of the disturbed stratum. In other words, hangar debris which was not consolidated at the north end of the hangar locus may simply have been buried when a moldboard plow turned over the soil. The identification of intact features, including an in situ post (Feature 1) indicates that remains of the actual hangar structure have survived earth moving and plowing associated with hangar demolition. Additional work would be required to ascertain the extent of the impact of demolition and debris consolidation on artifact distributions across the 1910 Hangar locus as a whole.

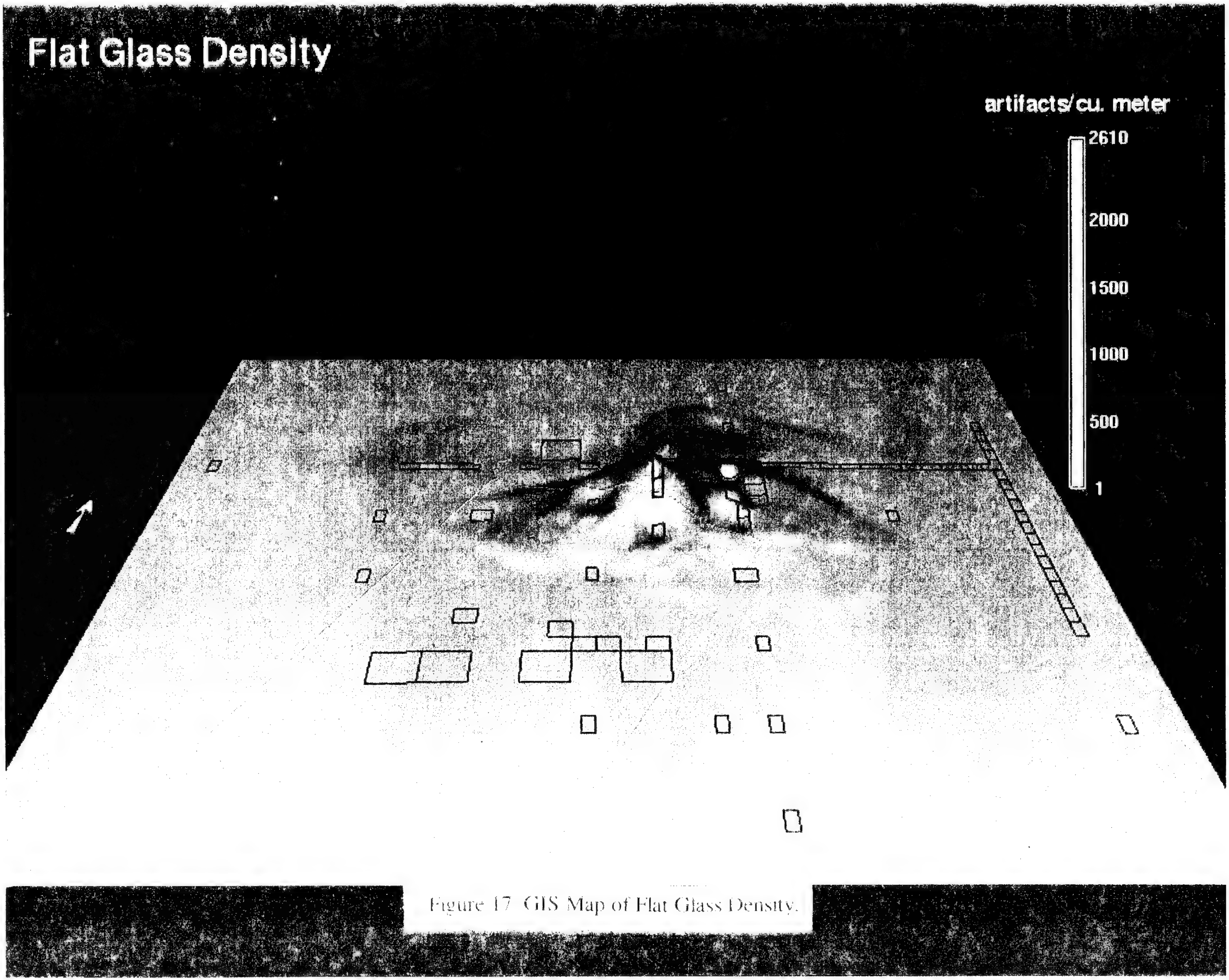

Figure 17. GIS Map of Flat Glass Density.

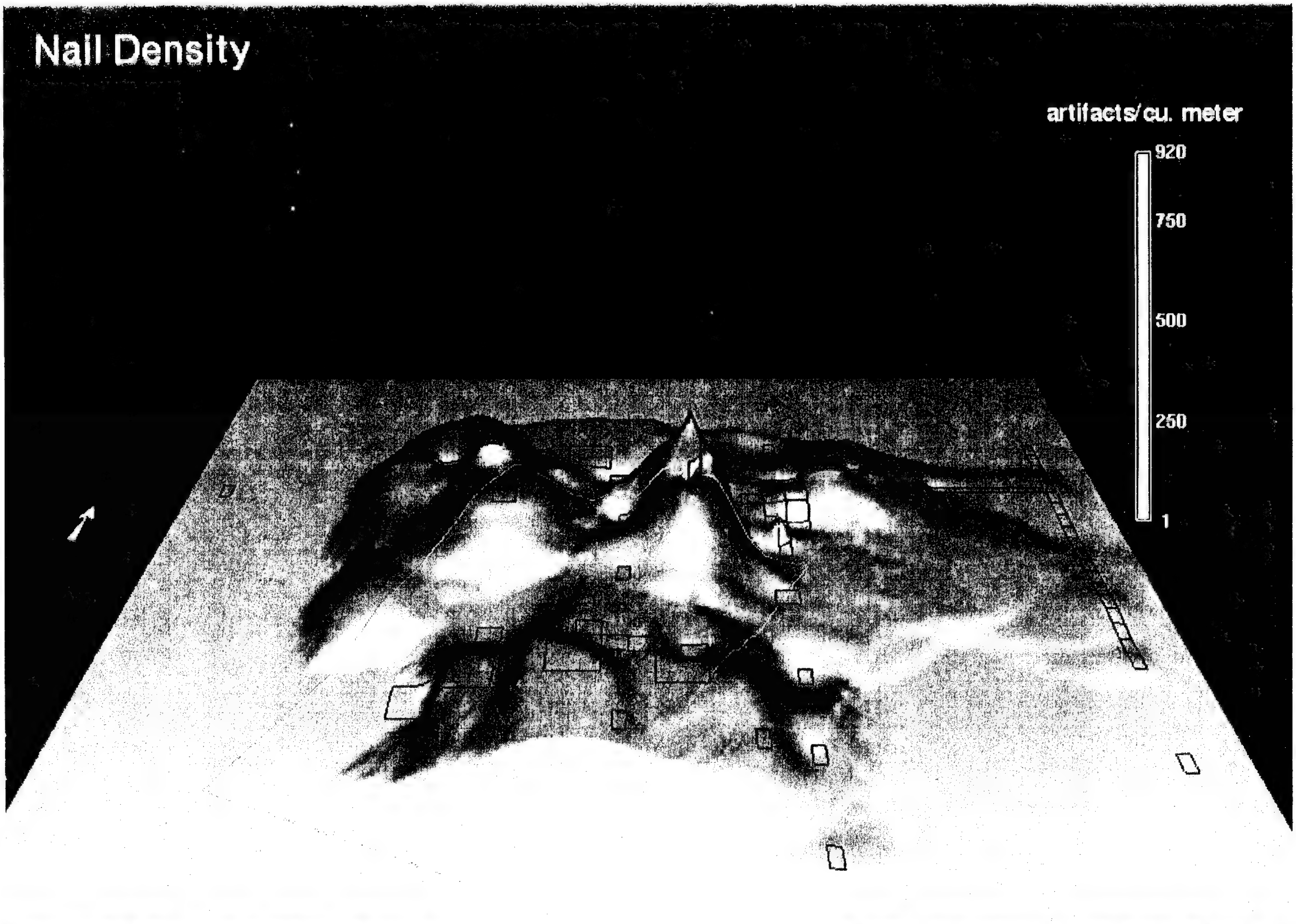

Figure 18 GIS Map of Nail Density.

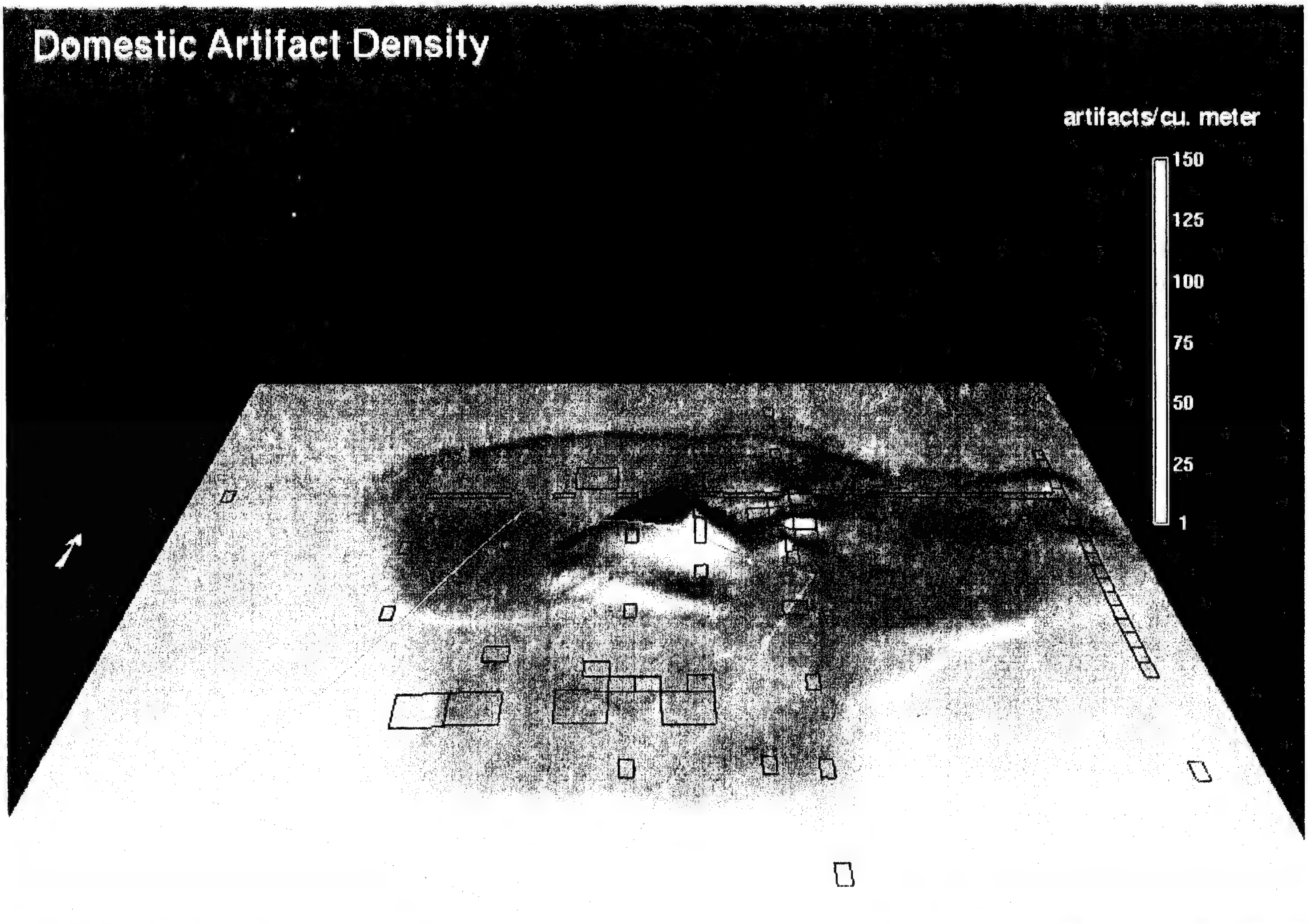

Figure 19 GIS Map of Domestic Artifact Density.

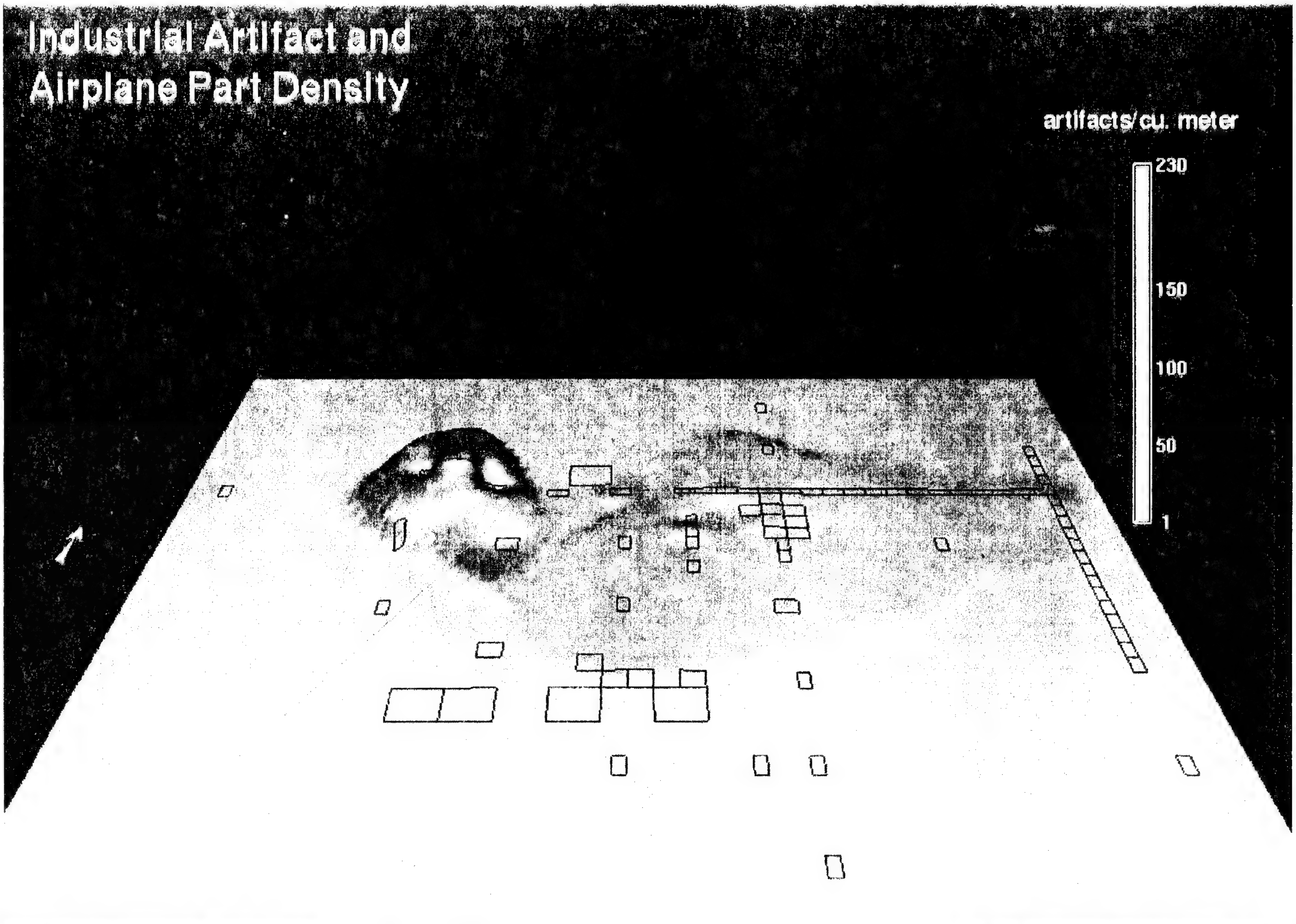

Figure 20. GIS Map of Industrial Artifact and Plane Part Density

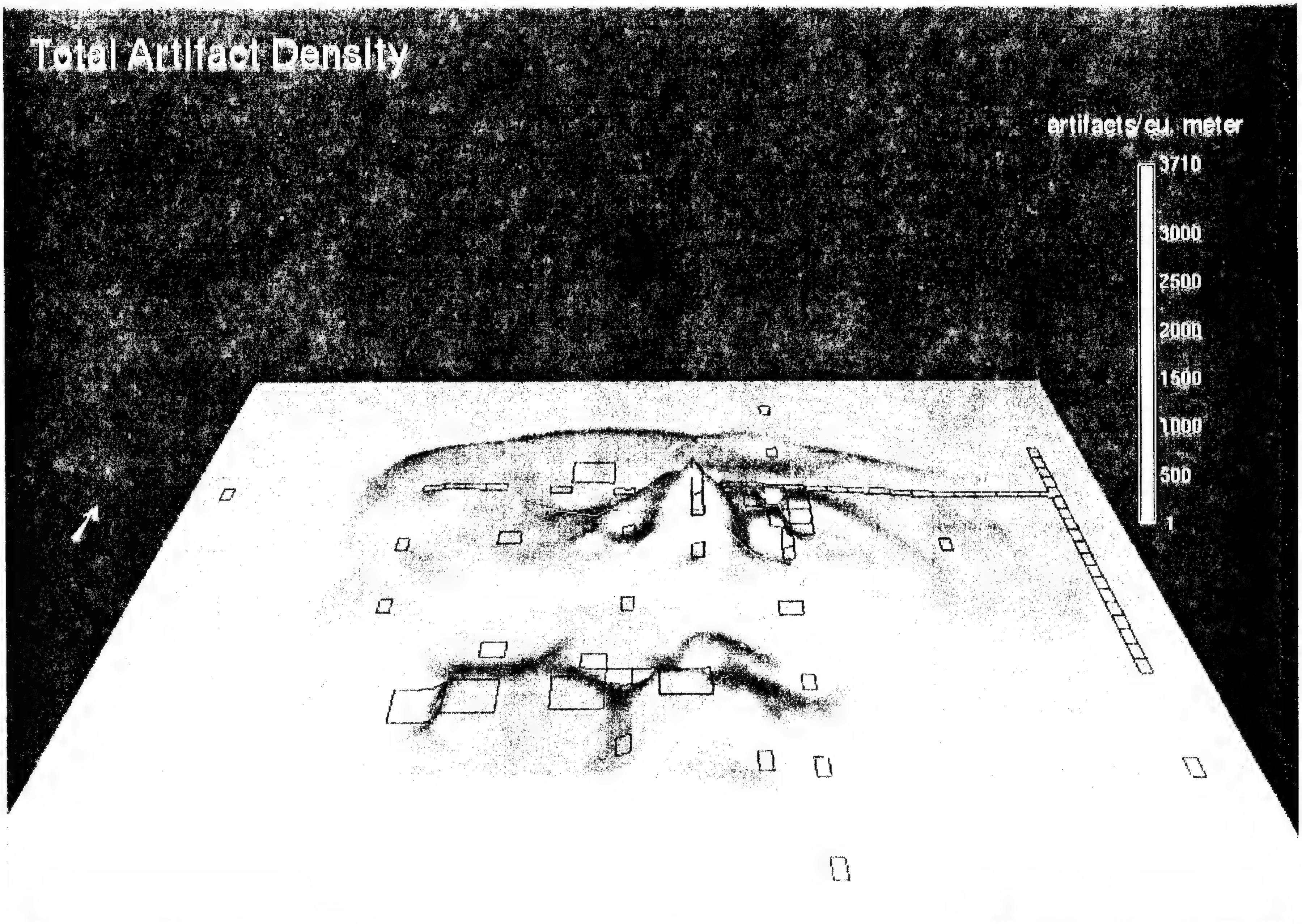

Figure 21. GIS Map of Total Artifact Density (All Categories).

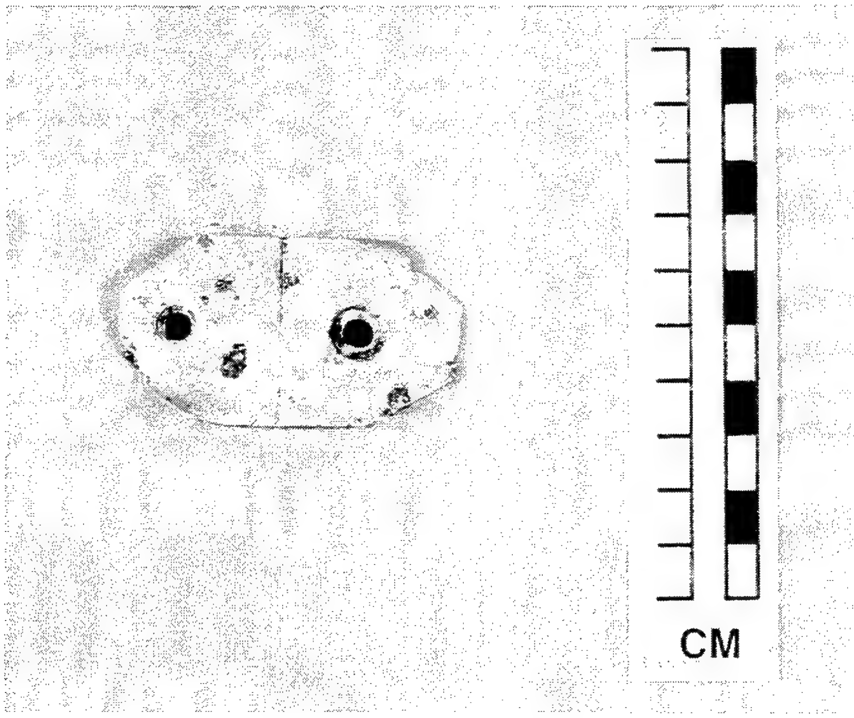

Plate 11. Aluminum Control Wire Guide, Unit 495N/387E.

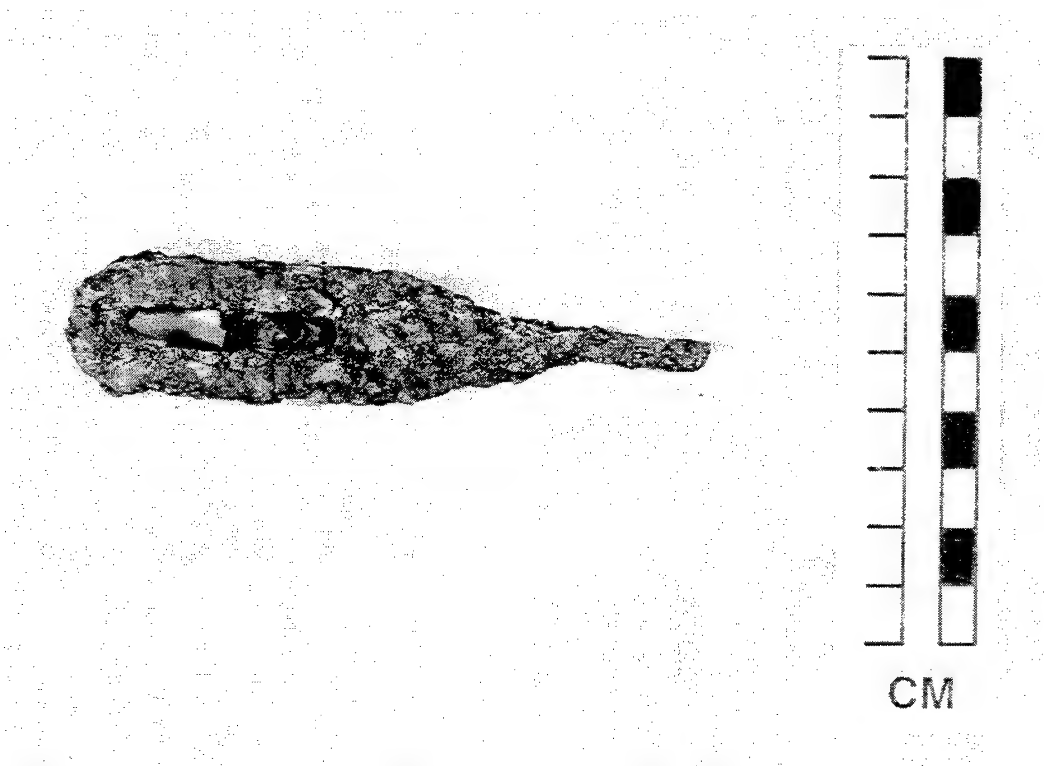

Plate 12. Iron Turnbuckle for Wing Struts, Unit 500N/385E.

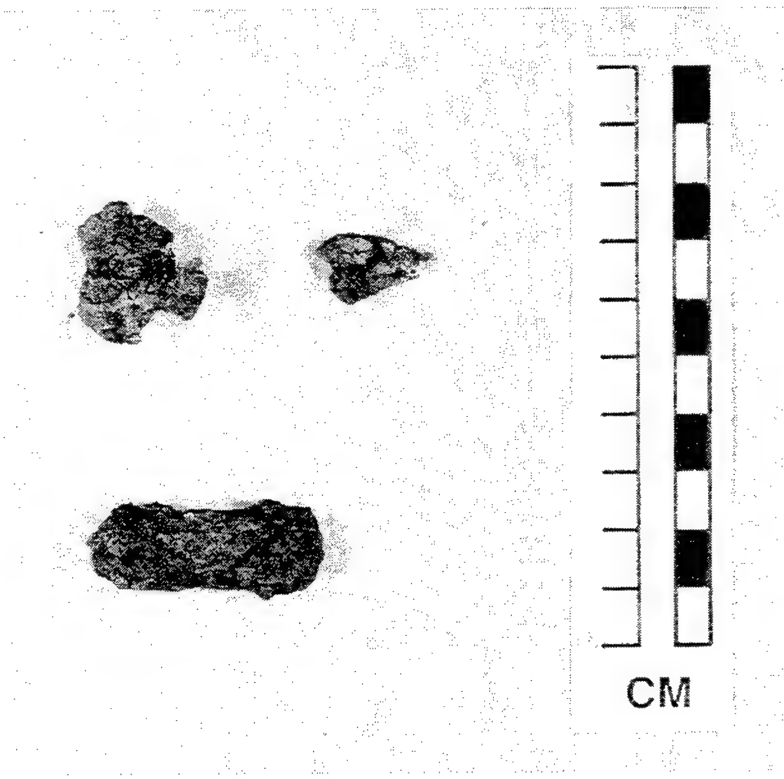

Plate 13. Drive-Chain Links, Units 498N/386E, 498N/388E,
and 498N/387E.

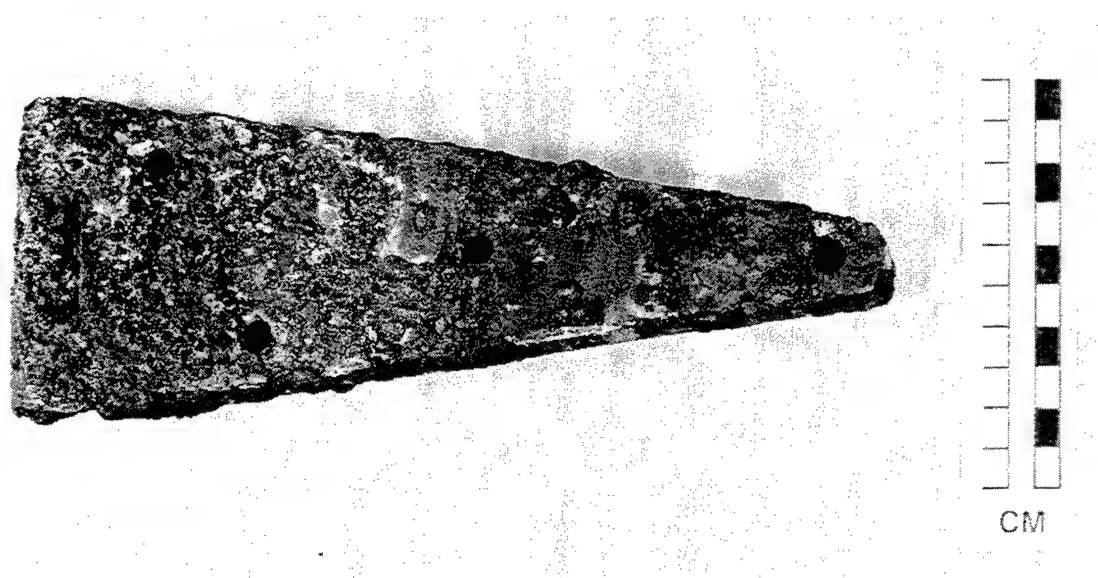

Plate 14. Steel Strap Hinge, Unit 483N/373E.

Table 1: Artifacts from 1990 and 1994 Excavations.

Unit	North m	East m	Volume m^3	Length m	Width m	Depth m	Glass Count	Glass Density	Nails Count	Nails Density	Domestic Count	Domestic Density	Airplane Count	Airplane Density	Other Count	Other Density	Total Count	Total Density
9001	509	387	0.1	0.5	1	0.2	0	0	1	10	0	0	0	0	0	0	1	10
9002	504	400	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9003	504	387	0.1	0.5	1	0.2	3	30	1	10	1	10	0	0	0	0	5	50
9005	502	400	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9008	501	400	0.1	0.5	1	0.2	0	0	0	0	2	20	0	0	0	0	2	20
9009	500	400	0.15	1	1	0.2	0	0	3	20	1	6.67	0	0	0	0	4	26.7
9010	500	399	0.1	1	0.5	0.2	0	0	2	20	0	0	0	0	0	0	2	20
9011	500	398	0.1	1	0.5	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9012	500	397	0.1	1	0.5	0.2	0	0	0	0	1	10	0	0	0	0	1	10
9013	500	396	0.1	1	0.5	0.2	1	10	2	20	1	10	0	0	0	0	4	40
9014	500	395	0.1	1	0.5	0.2	0	0	1	10	0	0	0	0	0	0	1	10
9015	500	394	0.1	1	0.5	0.2	0	0	7	70	1	10	0	0	0	0	8	80
9016	500	393	0.1	1	0.5	0.2	2	20	9	90	0	0	1	10	0	0	12	120
9017	500	392	0.1	1	0.5	0.2	6	60	19	190	0	0	0	0	0	0	25	250
9018	500	391	0.1	1	0.5	0.2	10	100	16	160	0	0	0	0	0	0	26	260
9019	500	390	0.1	1	0.5	0.2	10	100	23	230	0	0	0	0	0	0	33	330
9020	500	389	0.1	1	0.5	0.2	9	90	22	220	2	20	1	10	0	0	34	340
9021	500	388	0.1	1	0.5	0.2	30	300	7	70	4	40	0	0	0	0	41	410
9022	500	387	0.1	1	0.5	0.2	34	340	8	80	1	10	0	0	0	0	43	430
9023	500	386	0.1	1	0.5	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9024	500	385	0.1	1	0.5	0.2	47	470	11	110	1	10	2	20	0	0	61	610
9025	500	384	0.1	1	0.5	0.2	29	290	8	80	2	20	0	0	0	0	39	390
9026	500	383	0.1	1	0.5	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9027	500	380	0.1	1	0.5	0.2	9	90	11	110	0	0	1	10	0	0	21	210
9028	500	377	0.1	1	0.5	0.2	7	70	24	240	1	10	0	0	0	0	32	320
9029	500	374	0.1	1	0.5	0.2	0	0	45	450	1	10	1	10	0	0	47	470
9030	500	373	0.1	1	0.5	0.2	0	0	29	290	0	0	23	230	0	0	52	520
9031	500	372	0.1	1	0.5	0.2	9	90	22	220	1	10	21	210	0	0	53	530
9032	500	371	0.1	1	0.5	0.2	0	0	29	290	1	10	9	90	0	0	39	390
9033	500	361	0.1	1	0.5	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9034	500	351	0.1	1	0.5	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9035	499	400	0.1	0.5	1	0.2	0	0	0	0	0	0	1	10	0	0	1	10
9036	499	387	0.2	1	1	0.2	112	560	22	110	4	20	3	15	0	0	141	705
9037	498	400	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9038	498	388	0.2	1	1	0.2	81	405	33	165	5	25	2	10	0	0	121	605
9039	498	387	0.2	1	1	0.2	12	60	25	125	0	0	3	15	0	0	40	200
9040	498	386	0.2	1	1	0.2	123	615	19	95	2	10	1	5	0	0	145	725

Table 1: Artifacts from 1990 and 1994 Excavations.

Unit	North m	East m	Volume m^3	Length m	Width m	Depth m	Glass Count	Glass Density	Nails Count	Nails Density	Domestic Count	Domestic Density	Airplane Count	Airplane Density	Other Count	Other Density	Total Count	Total Density
9041	497	400	0.1	0.5	1	0.2	0	0	0	0	1	10	0	0	0	0	1	10
9042	497	388	0.2	1	1	0.2	65	325	24	120	9	45	0	0	0	0	98	490
9043	497	387	0.2	1	1	0.2	122	610	22	110	0	0	3	15	0	0	147	735
9044	496	400	0.1	0.5	1	0.2	1	10	0	0	2	20	0	0	0	0	3	30
9045	496	388	0.2	1	1	0.2	59	295	9	45	3	15	1	5	0	0	72	360
9046	496	387	0.2	1	1	0.2	171	855	18	90	6	30	0	0	0	0	195	975
9004	503	400	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9047	495	400	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9048	495	387	0.1	0.5	1	0.2	39	390	19	190	5	50	1	10	0	0	64	640
9049	495	380	0.1	0.5	1	0.2	59	590	18	180	0	0	0	0	0	0	77	770
9050	495	375	0.2	1	1	0.2	16	80	79	395	5	25	1	5	0	0	101	505
9051	495	370	0.1	0.5	1	0.2	0	0	19	190	0	0	0	0	0	0	19	190
9052	494	400	0.1	0.5	1	0.2	0	0	0	0	1	10	0	0	0	0	1	10
9053	494	387	0.1	0.5	1	0.2	18	180	3	30	2	20	0	0	0	0	23	230
9054	493	400	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9055	492	400	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9056	491	400	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9057	490	400	0.1	0.5	1	0.2	1	10	4	40	0	0	0	0	0	0	5	50
9058	490	387	0.2	1	1	0.2	2	10	13	65	5	25	0	0	0	0	20	100
9059	490	380	0.1	0.5	1	0.2	7	70	25	250	0	0	0	0	0	0	32	320
9060	490	370	0.1	0.5	1	0.2	1	10	21	210	0	0	0	0	0	0	22	220
9061	489	400	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9062	488	400	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9063	487	400	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9064	487	375	0.2	1	1	0.2	2	10	20	100	0	0	0	0	0	0	22	110
9065	486	400	0.1	0.5	1	0.2	0	0	2	20	0	0	0	0	0	0	2	20
9066	486	379	0.2	1	1	0.2	0	0	53	265	2	10	0	0	0	0	55	275
9067	485	387	0.1	0.5	1	0.2	0	0	1	10	0	0	0	0	0	0	1	10
9068	485	383	0.2	1	1	0.2	0	0	37	185	0	0	0	0	0	0	37	185
9069	485	381	0.2	1	1	0.2	5	25	51	255	2	10	0	0	0	0	58	290
9070	485	380	0.2	1	1	0.2	0	0	53	265	2	10	0	0	0	0	55	275
9071	480	387	0.1	0.5	1	0.2	0	0	6	60	0	0	0	0	0	0	6	60
9072	480	380	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9073	475	387	0.1	0.5	1	0.2	0	0	6	60	0	0	0	0	0	0	6	60
9074	480	385	0.1	0.5	1	0.2	0	0	0	0	3	30	0	0	0	0	3	30
9075	480	400	0.1	0.5	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0
9076	493	383	0.1	0.5	1	0.2	36	360	63	630	1	10	0	0	0	0	100	1000

Table 1: Artifacts from 1990 and 1994 Excavations.

Unit	North	East	Volume	Length	Width	Depth	Glass	Glass	Nails	Nails	Domestic	Domestic	Airplane	Airplane	Other	Other	Total	Total
m	m	m	m^3	m	m	m	Count	Density	Count	Density	Count	Density	Count	Density	Count	Density	Count	Density
9077	495	383	0.1	0.5	1	0.2	139	1390	48	480	0	0	1	10	0	0	188	1880
9078	495	394	0.1	0.5	1	0.2	2	20	8	80	3	30	0	0	0	0	13	130
9079	496	383	0.1	0.5	1	0.2	261	2610	92	920	15	150	3	30	0	0	371	3710
9080	497	383	0.1	0.5	1	0.2	192	1920	59	590	4	40	1	10	0	0	256	2560
9081	490	388	0	0	0	0	4	0	18	0	3	0	0	0	0	0	0	0
9082	485	383	0.1	0	0	0	1	10	0	0	0	0	0	0	0	0	1	10
9083	486	379	0.1	0	0	0	8	80	0	0	0	0	0	0	0	0	8	80
9084	480	385	0.1	0	0	0	5	50	18	180	0	0	0	0	0	0	23	230
9401	483	371	0.8	2	2	0.2	1	1.25	4	5	1	1.25	0	0	36	45	42	52.5
9402	483	373	0.8	2	2	0.2	27	33.75	187	233.75	7	8.75	0	0	226	282.5	447	559
9403	483	377	1	2	2	0.3	21	21	340	340	16	16	0	0	319	319	696	696
9404	483	381	0.8	2	2	0.2	19	23.75	211	263.75	11	13.75	0	0	842	1052.5	1083	1384
9405	501	377	0.9	2	2	0.3	15	16.67	143	158.89	10	11.11	1	1.11	101	112.22	270	300

Notes: Density=Count per m^3; Glass=flat glass; Unit numbers beginning with 90 are from 1990, those with 94 are from 1994.

Chapter 8
SYNTHESIS OF GEOPHYSICAL, REMOTE SENSING, AND ARCHAEOLOGICAL INVESTIGATIONS

From 1990 through 1994, USACERL led a multidisciplinary investigation of the Huffman Prairie Flying Field site at WPAFB, Dayton, Ohio. The objective of this work was to determine the precise location of a hangar built by the Wright brothers in 1910, and to assess the nature and depositional integrity of the hangar's archaeological remains. An additional objective was to collect archaeological, architectural, and historical information that would contribute to a better understanding of the site as a whole.

1990 Excavations

USACERL archaeological excavations in 1990 included a pedestrian survey and soil phosphate tests, followed by the hand excavation of test units and shallow trenches that exposed an area of 43 m^2. This initial work documented a concentration of artifacts associated with the 1910 Hangar but did not identify subsurface features. In view of the site's National Historic Landmark status, USACERL investigators determined that the dual goals of site assessment and site preservation could best be accomplished through the use of a suite of technologically sophisticated, noninvasive methods. In 1993, geophysical and airborne remote sensing surveys of the 1910 Hangar locus were conducted by CEWES and NASA, respectively. In 1994, USACERL conducted additional archaeological investigations at the site to ground truth (verify through excavation) the results of the noninvasive surveys.

Geophysical and Remote Sensing Studies

NASA's airborne remote sensing investigation used three techniques to search for the 1910 Hangar (see Appendix A, this volume). Color infrared photographs did not provide any new information about the Hangar's precise location. The CAMS (calibrated airborne multispectral scanner) produced a quality image of Simms road (no longer discernable on the surface) east of the hangar, and a faint rectangular image that corresponded to the size and position of the hangar as seen on early air photographs. A third instrument, the Inframetrics thermal scanner, detected the gullies which ran along both sides of Simms road. The Inframetrics also produced the best evidence for the hangar's location in the form of a clearly discernable, dark, rectangular area, or footprint. The Inframetrics image of the hangar footprint appears to be congruent with the size, shape, and position of the 1910 Hangar as seen on the 1924 air photograph.

At present, it is unclear what physical factors account for the hangar footprint detected by the Inframetrics. The footprint may result from soil compaction associated with activities taking place around the outside of the hangar, and the relatively uncompacted nature of the soil under the hangar floor. The structure footprint may also have been augmented by a rain drip line which formed around the hangar due to the lack of gutters and downspouts on the roof. Whatever the source of the hangar footprint, its detection suggests that thermal infrared imaging is a potentially powerful tool for archaeological site investigation.

The geophysical (magnetic, electromagnetic, and GPR) surveys conducted by CEWES identified rectangular anomalous areas that corresponded well to the georeferenced location of the 1910 Hangar as shown on a 1924 air photo. An additional rectangular area of GPR anomalies (overlapping with those described above) corresponds to the distribution of artifacts documented by USACERL in 1990 (Butler et al. 1994:41-42). On balance, the geophysical surveys appear to have located the 1910 Hangar based on the distributions of artifacts and possibly, of archaeological features.

Both the geophysical and airborne remote sensing studies produced evidence for the exact location of the hangar. The 1994 excavations corroborate the results of the two non-invasive studies. The combination of thermal infrared imaging and geophysical techniques with targeted "ground truthing" excavations offers great potential for improving the reliability of assessments of site integrity and intra-site organization.

1994 Excavations

The 1994 USACERL test units indicate that the project area has been plowed very little since the construction of the hangar in 1910. At the time of construction, the area was in pasture. It is likely, however, that the project area was under cultivation at some time during the second half of the 19th century. A 15-20 cm. plowzone was identified in the north wall profile of Unit 501N/377E (see Figure 14). This is a little thick for a 19th century plowzone resulting from horse-drawn plowing, but that nevertheless represents one explanation for this stratum.

Evidence for a disturbance of the uppermost 20 cm. was noted in the units located along the 483N line as well as in Block B (Figure 6, page 29). Here the soil was much looser than in the plowzone defined in 501N/377E (Figure 14, page 46). This disturbance is assumed to result from activities associated with the demolition of the hangar in the 1940s. The extent of earthmoving is quite important to present and future interpretations of the archaeological remains of the hangar. For example, a bulldozer may have been used to knock down the hangar and consolidate the larger portions of the wall and roof debris into one or several piles. Hardware which remained affixed to wood members, including items such as hinges and other mountings from the large hangar doors, may have been moved some distance from their original position at the south end of the building. Other pieces of hardware which had been discarded near the building during the interval of hangar use, at the time of the 1924 remodeling, or while the hangar stood vacant before and after the 1924 Air Show, may have already become incorporated into the humus layer. Such items may not have been displaced, particularly if the bulldozer was used simply to scrape the surface so as to consolidate the larger pieces of debris. On balance, the presence of 20 cm of disturbed soil may also be explained by the use of a moldboard plow to turn under the remaining debris. Such plowing may not have moved artifacts any great distance (Roper 1976).

The identification of three features, including a well preserved, in situ, unburned wood post, represents an important result of the 1994 investigations. These features are located in units on the 483N line, in the central part of the hangar footprint (Figure 6, page 29). The features almost certainly relate to the 1910 Hangar, but it is unclear what kind of structural elements they represent. The presence of these well preserved features demonstrates conclusively that the 1910 Hangar locus possesses a high level of archaeological integrity, despite the fact that up to 20 cm of the uppermost deposits have been disturbed by earthmoving and/or plowing.

Nature and Integrity of Hangar Remains

The 1990-1994 investigations by USACERL, CEWES (Butler et al. 1994), and NASA (Sever, Appendix A) have provided substantial information about the nature and integrity of the archaeological remains of the 1910 Hangar. Subsurface remains of the hangar include well preserved, in situ wood posts, postholes, and possibly other types of features. The very dark color and blocky texture of the soil matrix makes it difficult to identify feature outlines. Nevertheless, features associated with hangar wall posts and other structural elements can be recovered through careful excavation. Overlying the subsurface features is a stratum of disturbed soil ranging in thickness up to approximately 20 cm. This stratum may result from bulldozing and plowing performed at the time of hangar demolition in the early 1940s. This earthmoving was presumably a result of consolidating debris from the demolished hangar into a single pile. This action resulted in a concentration of artifacts north of the hangar footprint. It is possible (but not presently documented) that peripheral areas of the hangar locus remain undisturbed. Artifacts related to specific activities such as aircraft maintenance and repair may remain in situ in those areas.

Magnetic anomalies identified by the CEWES geophysical survey (Butler et al. 1994) represent interesting and potentially important aspects of the 1910 Hangar locus. Of note is the strong anomaly identified as "B" (Butler et al. 1994:18-19; Figure 6, this volume, page 29). This anomaly was not investigated by the 1994 excavation program, but it (and the other anomalies identified by CEWES) should remain a focus of future investigations. Anomaly B is believed to be a large, buried, ferrous object (Butler et al. 1994:18). It could be an aircraft component, tool or machine, structural component of the hangar, or concentration of iron objects. Further investigation of the CEWES anomalies would aid greatly in understanding site structure.

Artifacts are relatively abundant at the 1910 Hangar locus and, as noted previously, are very informative about the nature of activities conducted at the site. The assemblage as a whole is dominated by construction materials. Airplane parts are few in number but provide direct evidence for the repair and operation of early aircraft. Domestic items are represented primarily by fragments of glass beverage bottles. These artifacts provide some insight into the daily lives of the pilots, mechanics, and other individuals who spent time at the 1910 Hangar locus. A majority of the artifacts recovered in 1990 and 1994 are from units located within the main artifact concentration. These items were, as explained, presumably relocated at the time of hangar demolition. Despite the earthmoving and plowing associated with the demolition, there appears to be some integrity to the horizontal location of some artifacts. For example, the door hinge, bolts, and washer found in units excavated in the central portion of the hangar footprint all appear to be related to the main doors in the south wall. Despite demolition, items that were in close proximity during use were recovered near one another. Future excavations at the site should include additional hand excavation to recover in a controlled manner artifacts from all portions of the hangar locus.

Chapter 9
RECOMMENDATIONS FOR SITE MANAGEMENT

The archaeological, historical, geophysical, and airborne remote sensing investigations reported in this monograph have precisely located the 1910 Hangar, verified its specialized use as a facility for aircraft maintenance and operation, and established that in situ architectural remains are present, well preserved, and recoverable. As such, the 1910 Hangar locus, and the larger Huffman Prairie Flying Field site have the potential to provide important and, in some ways, unique information about the development of powered heavier-than-air flight. The site also has great potential as a vehicle for public education. Based on these findings, we offer the following recommendations for site management.

Care should be taken to preseve the physical, in-ground remains of the 1910 Hangar. Management of the cultural resources of Huffman Prairie Flying Field should be undertaken by Wright-Patterson Air Force Base in consultation with the National Park Service. When the site reaches 100 years in age (2004), it should be posted as a federally-owned archaeological site, subject to the rules, restrictions, and penalties of the Archaeological Resources Protection Act of 1979, as ammended.

No reconstruction of the 1910 Hangar, on or off site, should be undertaken before large-scale excavation of the archaeological remains is performed. If the hangar is to be reconstructed in its original location, complete excavation will be necessary in order to recover information and artifacts that would be damaged or destroyed. These is no way to build such a replica on top of the 1910 Hangar without damaging or destroying the fragile post and posthole features which exist at approximately 20 cm. below surface.

One option is to construct a replica of the hangar a short distance away from the actual 1910 Hangar locus. In this case, partial excavation of the 1910 Hangar could be undertaken to guide the reconstruction, and to ensure that it is as accurate as possible. Such excavations are desirable given the absence of plans or blueprints for the 1910 Hangar in the archives of the Wright Aeronautical Company. Excavation of the hangar to inform an off-site reconstruction should be designed so as to preserve in situ the archaeological remains of the actual hangar. Excavation of approximately 50% of the structure is recommended. This strategy would reduce excavation costs and provide for possible future investigations as archaeological techniques improve and research questions change. Compliance with Section 106, NHPA 1966 (as amended), will require that any area selected for the hangar reconstruction also be inspected for cultural resources.

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Appendix A
REMOTE SENSING STUDY OF THE 1910 HANGAR LOCUS

by Thomas L. Sever

Introduction

Discussions were held in the Fall of 1992 between Keith Landreth, USACERL, and Dr. Tom Sever, NASA-Stennis Space Center, to review the possibility of using remote sensing technology in environmental and cultural resource inventories at Wright- Patterson Air Force Base (WPAFB). As a result of these discussions, a visit was made in February 1993 to meet with WPAFB personnel to demonstrate the capability of remote sensing technology and to determine which research applications were potentially beneficial. The NASA representatives were Dr. Tom Sever, Earth Science Division, and Gerald Meeks, Optics and Sensor Laboratory. Approximately 35 WPAFB personnel were present at the meeting which was sponsored by Dr. Jan Ferguson, Base Historic Preservation Officer at WPAFB.

A strategy was developed as a result of this visit that would select the optimum airborne remote sensing instrument to address the wide range of research activities. These activities included the detection or delineation of the following:

1. The 1910 Wright Brothers hangar;
2. Heating plant plumes;
3. Base-wide heat/energy loss in buildings;
4. Wetland areas;
5. Underground storage tanks and leaks;
6. Native American burial mounds;
7. Underground utilities; and
8. Hazardous waste sites.

Although this report centers upon research associated with the 1910 Hangar locus, the original research design called for a data acquisition plan that would address interdisciplinary research across the entire base. The subtle variations and spatial limitations associated with the 1910 Hangar were initially identified as a difficult challenge to remote sensing detection. A detailed discussion of the research carried out on the 1910 Hangar area appears later in this report.

The thermal portion of the electromagnetic spectrum appeared to be critical for successfully addressing many of the research objectives of the Wright-Patterson investigators. This was based upon past NASA research in thermal imaging for propulsion and earth science investigations. In addition, previous archeological studies had successfully employed narrow-band, thermal imaging in locating prehistoric roadways in the Southwest, ancient footpaths in Costa Rica, and cultural features at the Poverty Point site in Louisiana.

The Airborne Terrestrial Applications Sensor (ATLAS) scanner would have been ideal to meet these challenges since it contained bandwidths in the visible, near infrared, and thermal infrared. This new, state-of-the-art sensor was in the final stages of development and was scheduled

to become operational in April, 1993. In addition to the six narrow, thermal bands, nine visible and near infrared bands could be used to address vegetation studies. To date, the ATLAS remains the only airborne scanner which renders such a wide range of bandwidths. Delays in the ATLAS development, however, precluded it's use at Wright-Patterson.

The second choice in multispectral scanning instruments was the Thermal Infrared Multispectral Scanner (TIMS). Unfortunately, the TIMS was unavailable since it was on assignment for interdisciplinary research in Australia. As a result the Calibrated Airborne Multispectral Sensor (CAMS) was selected, despite the fact that it contains only one, broad-range thermal band. The author was skeptical that this single thermal band would be useful in locating the 1910 Hangar. Because of this fact, the Inframetrics hand-held scanner was selected as a complementary thermal imaging instrument and was mounted in a light aircraft to determine its utility in detecting features associated with the 1910 Hangar locus.

Finally, as an additional aid in feature detection, a series of simultaneous color infrared (CIR) photographs was also taken at a scale of 1:12,000.

Sensors

Although only the CAMS and Inframetrics scanners were employed in this investigation, a description of all the scanners mentioned above is included. This information will hopefully assist future investigators in the selection of remote sensing instrumentation that will best address their research focus.

Airborne Terrestrial Applications Sensor (ATLAS)

The ATLAS sensor represents a significant advancement in the availability and adaptability of a multispectral remote sensing instrument with its minimized cost, size, and weight (DaMommio and Kuo 1992; Birk and Spiering 1992). The experimental sensor became operational in 1994. The instrument acquires data in 15 channels from the visible through the thermal infrared region (0.4-12.2 micrometers). In short, the ATLAS combines the bands of the CAMS and TIMS into one instrument (see below). The instrument has a ground spatial resolution ranging from 2-25 m., with design emphasis on spatial resolutions under 10 m. Both the reflective and emissive calibration are traceable to national standards. The ATLAS incorporates accurate aircraft attitude and geolocation knowledge to provide the capability to produce imagery with good geometric fidelity. This will allow flight lines of data to be joined together accurately and inexpensively -- a great improvement over previous techniques. Direct digital recording allows the data to be used without decommutation while fiber optics reduce signal-to-noise ratios.

Thermal Infrared Multispectral Scanner (TIMS)

The TIMS is a six channel thermal infrared multispectral scanner capable of measuring radiation in 400 nanometer intervals from 8.2 to 9.4 micrometers, and in 800 and 1000 nanometer intervals from 9.4 to 12.2 micrometers. The 6 thermal bands were originally designed for geological research (Kahle and Goetz 1983). The scanner has been modified through time and has been successful in

vegetation research (Sader 1986), soil research (Pelletier and Ochoa 1986), and archeology (Sever and Wiseman 1985).

The uniqueness of TIMS lies not only in its thermal infrared capability but also in its multispectral nature. Each of the six bands measures thermal radiation as temperature in degrees of Centigrade. Emissivity of the target, the ratio of radiant emission of a source to that of a black body at the same temperature, also contributes to the measured return. Emissivity is a function of the type of material and its surface geometry. The TIMS instrument can achieve a sensitivity of better than a tenth of a degree Centigrade (Palluconi and Meeks 1985:5). Operationally, surface temperatures to one half degree Centigrade can be achieved through atmospheric corrections.

Gibson (1987:113-134) used TIMS data to locate several prehistoric features at Poverty Point, Louisiana, such as an "aisle" that was visible in a 1964 aerial photograph, and a "bisector ridge" that was visible only in 1927 and 1934 aerial photographs. These features were visible in the 1985 TIMS data but not in the simultaneously acquired color infrared (CIR) photography. TIMS data also detected prehistoric Anasazi roadways that were not visible in the simultaneously acquired CIR photography (Sever 1983, 1990). The thermal properties of archaeological data were noted when the daytime data revealed roadways and buried wall features but not a prehistoric agricultural field. Conversely, the 10:00 pm (local) night data did not show the roadways or buried features but delineated the agricultural field (Sever 1983, 1990). Bennett et al. (1985) used TIMS data for archaeological research along the Red River in Oklahoma. The TIMS was also used to detect prehistoric footpaths in Costa Rica (Sheets and Sever 1988, 1991). Currently, TIMS data are being used to detect archaeological features in the Peten of northern Guatemala (Miller et al. 1991:121-35; Sever 1992).

Calibrated Airborne Multispectral Scanner (CAMS)

The CAMS was designed and constructed at the Stennis Space Center in 1987 to meet the demands of investigators who requested that calibration data be recorded in real time with their mission data. The CAMS is a nine channel airborne instrument that provides coverage from 0.45 to 12.5 micrometers. CAMS remains an experimental sensor as ongoing research is completed.

Although final analysis is not completed, CAMS data have been acquired for archaeological research over northern Mississippi; Poverty Point, Louisiana; Hopewell earthworks in Ohio; and northern Guatemala. These data sets are part of ongoing NASA remote sensing/archaeological research. In general, CAMS works best in areas characterized by vegetation cover and was less effective in areas of sand and soil exposure (Sever 1990:179).

Inframetrics

The Inframetrics Model 740 scanner is a light-weight thermal instrument that is currently used in support of NASA's space shuttle program. The instrument, originally employed for ice-detection on the shuttle, has seen expanded application, including the detection of hydrogen leaks. It is a hand-held instrument that can be also be installed in a helicopter or fixed-wing aircraft. The Inframetrics has a sensitivity to 0.1 degrees Centigrade and is one of the most powerful thermal instruments that is commercially available at this time. The imager can, for example, detect the studs behind the

wallboards at Stennis Space Center (SSC) and record hand prints several minutes after one touches the wall. In Kansas and Nebraska, twelve year-old plow marks were visible in aircraft-acquired Inframetrics data over a mature corn field even though the phenomenon was not visible to the naked eye (Charles Thurman, pesonal communication, 1993). The instrument is currently being tested for archaeological potential from both air and ground levels by NASA at several test areas.

Data Collection

Data were acquired on May 11 and May 12, 1993, by the Inframetrics scanner mounted in a Grumman AA5 low-wing aircraft. A color video camera was also mounted in the aircraft for simultaneous data acquisition. The audio portion of the video camera was used to narrate position and altitude commensurate with the data acquisition time since there was no GPS or analog recording system in the aircraft. On May 11 the Grumman collected data over the 1910 Hangar locus on eleven passes. Conditions were cloudy and rain had fallen prior to data collection. On May 12 only two passes were made over the area due to continual rainfall and inclement weather. Conditions were less than ideal for data collection on either day and it was hoped that another mission could be scheduled in the future under drier conditions. Unfortunately, this second mission could not be undertaken.

CAMS data were acquired over WPAFB on August 4, 1993 at 5 m. ground resolution. Color infrared photography (1:12,000 scale) was collected simultaneously with 60% forward overlap to allow for stereoscopic viewing. Mission preparation determined that four flight lines of data were required to cover the entire base. Due to intermittent cloud conditions, the mission was flown twice in the hope that a mosaic of cloud-free data could be produced. Since the NASA Lear Jet was to be deployed for several weeks to Russia, this was the last opportunity to collect airborne data during 1993.

Analysis and Interpretation

All flight lines of CAMS data were decommutated and reformatted. Image analysis was conducted using NASA's ELAS image processing software (Graham et al. 1984). The simultaneously acquired CIR photography was shipped to WPAFB as requested by Dr. Jan Ferguson.

It was determined that CAMS bands 2, 4, 7, 8, and 9 were best for data analysis. Bands 1, 3, 5, and 6 exhibited low signal-to-noise ratios. Preliminary data analysis indicated that the CAMS data could be useful for a wide-range of research activities such as wetlands delineation, facilities management, and change detection, although particular attention was focused upon the 1910 Hangar locus. It should be emphasized that CAMS data collection occurred at an inappropriate time of the year (late Summer) for purposes of detecting features associated with the 1910 Hangar. Early Spring would have been a more favorable season for data collection, but scheduling difficulties precluded this possibility.

Filtering techniques were applied to the CAMS data to accentuate linear and curvilinear patterns. Due to the subtle nature of the 1910 Hangar remains, another technique was applied that was successful in detecting prehistoric roadways in Chaco Canyon, New Mexico (Sever 1990). This consisted of rotating a sine function on the image and overlaying a graphic onto linear segments in the 1910 Hangar locus as they became visible.

Data from the Inframetrics Scanner were stored on VHS tapes. To analyze these data for feature extraction, the data first had to be converted from analog (VHS tape) to a digital image. This was accomplished using a commercially available PC-based image capture board. The video signal from a VHS player was connected to the analog-in port of the image capture board. The operator could view the images directly on the computer screen. The video tape was advanced frame-by-frame. When an image was identified for processing, it was "captured", or digitized to generate a digital image. The captured images were saved for analysis or display.

Mosaicked images were created over the 1910 Hangar locus. To produce a mosaic, several images were captured in sequence so that there were regions of overlap between two "adjacent" images. Adjacent images were merged, or overlaid, by selecting two registration points (points in common) from each image. The files were digitally registered to each other to produce a mosaicked image. This process was repeated until a final image was produced.

The process of converting, transferring, and mosaicking Inframetrics images resulted in a loss of signal fidelity when hard copies were produced. In short, many features that could be viewed on the computer screen lost definition by the time an output product was made. A more automated process has since been defined to remedy this problem and will be available for future investigators who acquire data in a VHS format.

Results

The results of these different imaging techniques are presented in Figures A1 through A8, and include CIR photography (Figure A1), CAMS multispectral imagery (Figures A2-A5), and Inframetrics thermal imagery (Figures A6-A8).

Several features could be seen in both the CAMS and Inframetrics data. For instance, a buried linear feature (a pipeline) could be seen crossing the field east of Pylon road in the CAMS data. This feature was especially apparent in the thermal infrared band (Band 9) (Figure A5), but feature was not apparent in the simultaneously acquired CIR photography (Figure A2).

It was originally hypothesized by the author that the remains of the 1910 Hangar could be detected by the accumulation of petroleum products over the years on the floor of the structure. Later it was learned that the 1910 Hangar had a wood floor which was eventually removed. While the detection of petroleum remains has been successful in other studies, the wood floor would have prevented the creation of a detectable signature related to the spillage of gas or oil. Both the CAMS and Inframetrics data revealed the remains of Symmes road. The Inframetrics data appear to detect the gullies adjacent to the roadway (Figures A 6-A8), while the CAMS data seem to detect the roadway itself (A 3-A5). This appears to be due to the difference in ground resolution (5 m. for CAMS; .61 m. for the Inframetrics).

A 1911 aerial photograph was used to reference an approximate position for the 1910 Hangar. This oblique photograph was taken from a Wright Flyer aircraft and shows Symmes road as well as the hangar itself (see Butler et al. 1994: Figure 1). This approximate area was intensively analyzed in both the CAMS and Inframetrics data. Several other linear features adjacent to this area were noticed (i.e., possible early fence lines), but the focus turned to specific detection of potential features associated with the 1910 Hangar itself.

In the analysis of the CAMS data, a very subtle rectangular feature could be identified by rotating a sine function behind the image. This rectangular feature was only detected in Band 4 (Figures A3 and A4) and Band 9 (Figure A5) of the CAMS data. The area is identified in Figure A4 by a rectangular overlay adjacent to Symmes Road, which is also indicated. All other bands did not reveal the feature. This feature seems to approximate the position and dimensions of the 1910 Hangar locus based on the 1911 aerial photograph, and agrees reasonably well with the hangar location as seen in a vertical aerial photograph taken in 1926 (see Butler et al. 1994: Figure 2). However, the relatively small scale of the image makes it difficult to compare with the approximate hangar location derived from geophysical prospecting techniques (Butler et al. 1994).

The mosaicked Inframetrics images (Figures A6-A8) clearly define linear features and geological patterns that were not visible in the simultaneously acquired color video camera. Foremost of these is the rectangular "footprint" of the 1910 Hangar and the remains of Symmes Road, specifically, the gullies adjacent to the road. The hangar footprint is most clearly distinguished by a darkened area along the southwest side or front of the building; both the southwest and southeast corners of the structure are clearly visible (see Figures A6-A8). An L-shaped linear feature is also visible immediately to north and demarcates the northwest corner of the structure (see Figures A6-A8). The northeast or back wall of the hangar runs parallel to the two subsurface gullies which delimit Symmes Road, as can be seen in the 1924 aerial photograph (cf. Butler et al. 1994: Figure 2). It should be mentioned that the precise location of these features in the data could be accurately related to the ground through the use of GPS technology.

In spite of the clarity of these linear features and corner features, it is uncertain if they represent remnant architectural elements of the 1910 Hangar itself or thermal soil anomalies resulting from activities associated with the building. For example, the dark zone at the front of the building may represent repeated use of this area for the movement of aircraft in and out of the hangar as well as for routine aircraft maintenance activities.

In summary, potential features associated with the 1910 Hangar locus were detected in both the CAMS and Inframetrics data. The linear features and corners detected by the Inframetrics scanner have not been conclusively verified by archaeological investigation, although the 1994 excavations by USACERL investigators (as reported in this volume) revealed architectural elements and artifacts consistent with the presence of the 1910 Hangar. In spite of the success of these imaging techniques, however, data collection was not conducted under ideal conditions for the kind of feature detection desired. As a general recommendation for future studies of this kind, the following strategy would provide more optimal conditions for archaeological feature detection:

1. Only use narrow-band thermal instrumentation such as that available on the TIMS or ATLAS.

2. Acquire the data in the early Spring at both solar noon and pre-dawn in order to limit vegetation confusion and to allow data acquisition at thermal maximums.

3. Acquire the data at 2-4 m. resolution.

4. Acquire broad-band thermal Inframetrics data at the same time TIMS or ATLAS data are acquired and overlay the data sets for comparative analysis.

5. Acquire differentially corrected GPS data to relate digital data to precise locations on the ground.

6. Conduct preliminary in-field ground visits during the data analysis period and bring remotely sensed images into the field using a lap-top computer.

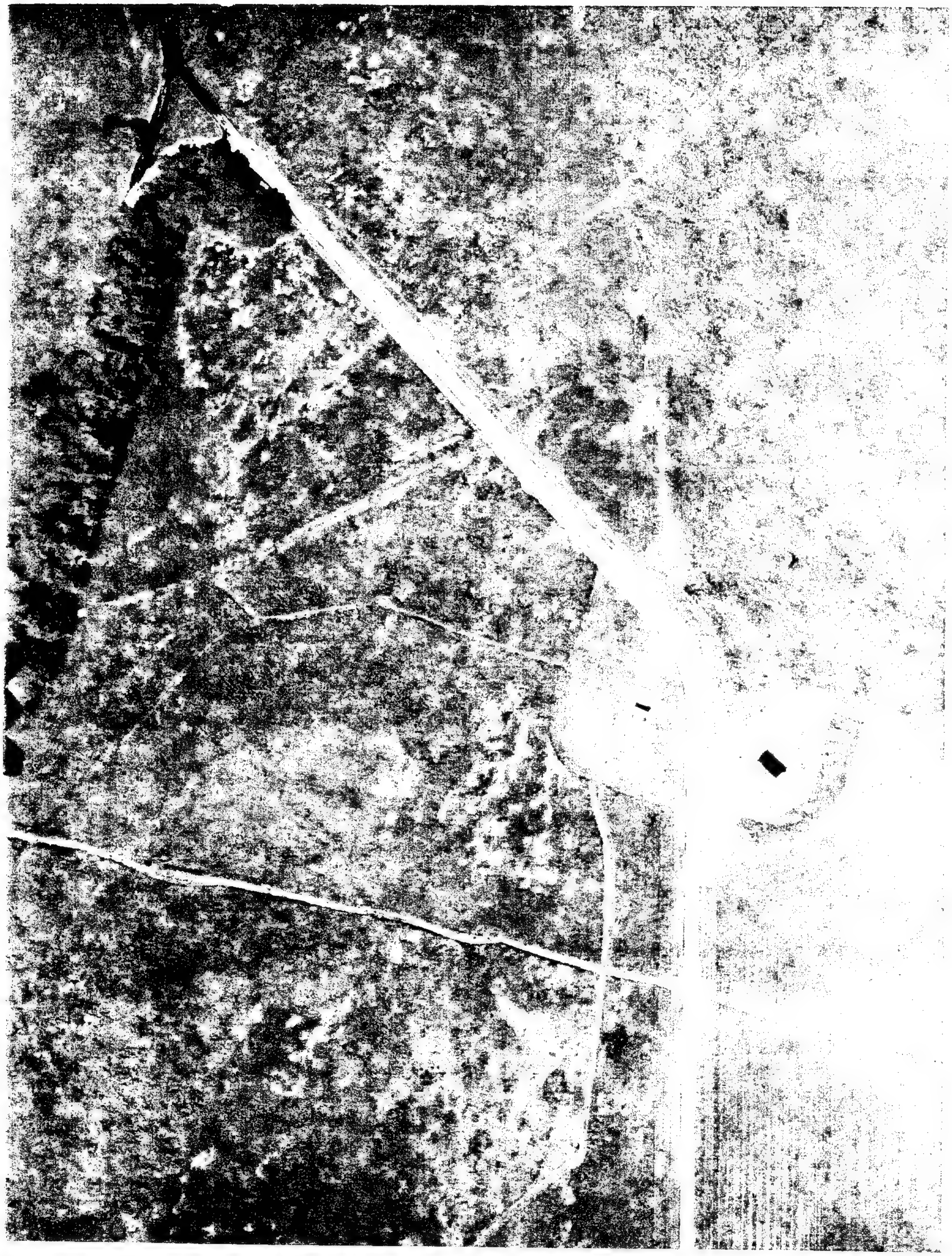

Figure A1. Color Infrared Photograph Over Huffman Prairie/1910 Hangar Locus

Figure A2. CAMS Color Composite Image Over Huffman Prairie/1910 Hangar Locus, Bands 2, 7, and 8.

Figure A3. CAMS Image, Flight 4-1, Band 4, at 1x.

Figure A4. CAMS Image, Flight 4-1, Band 4, at 3x, Showing Potential Location for the 1910 Hangar and Symmes Road.

Figure A5. CAMS Image, Flight 4-1, Band 9, at 1x.

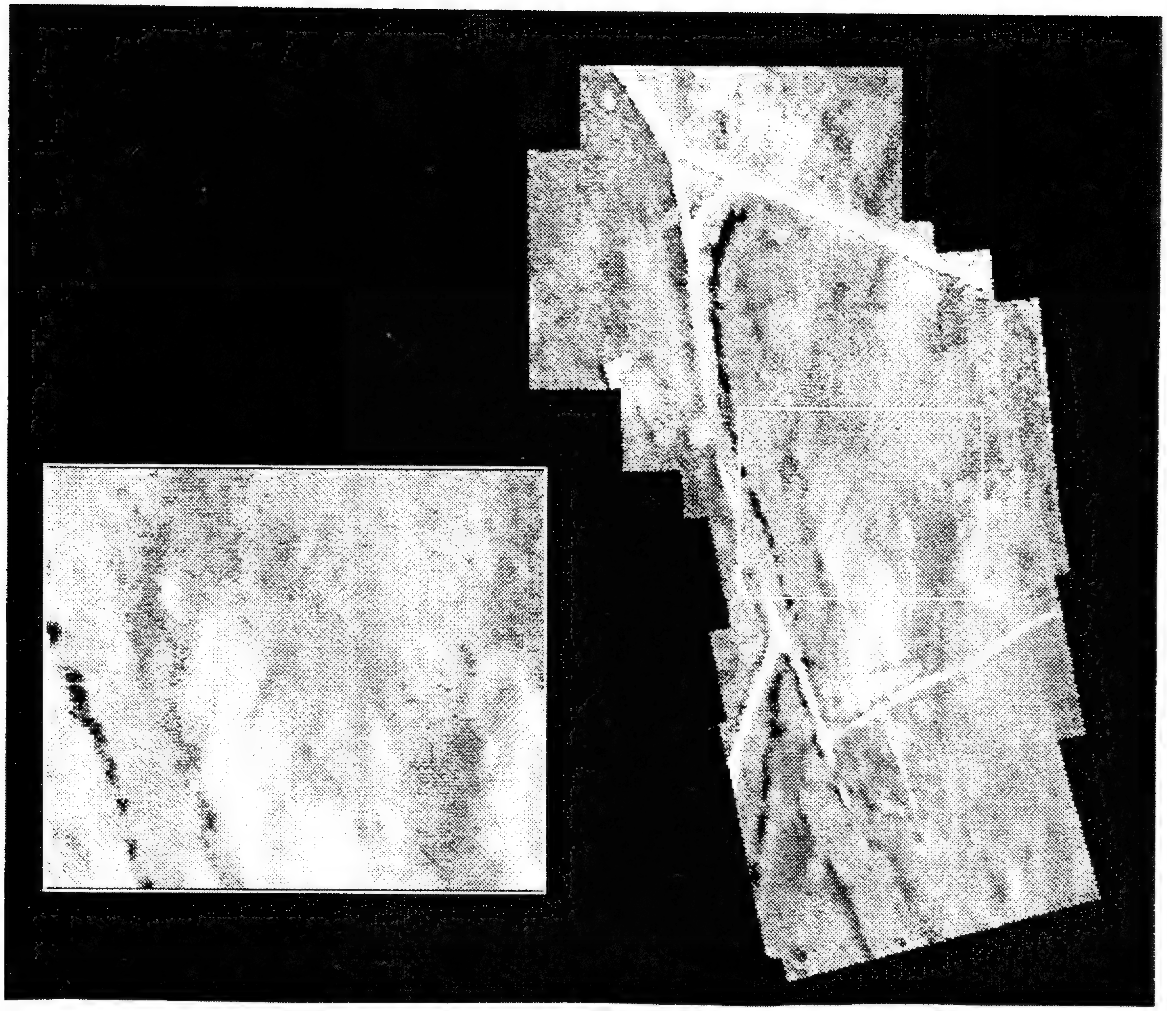

Figure A6. Inframetrics Video Mosaic at 1x with Blow-up of 1910 Hangar Footprint and Subsurface Gullies Delimiting Symmes Road.

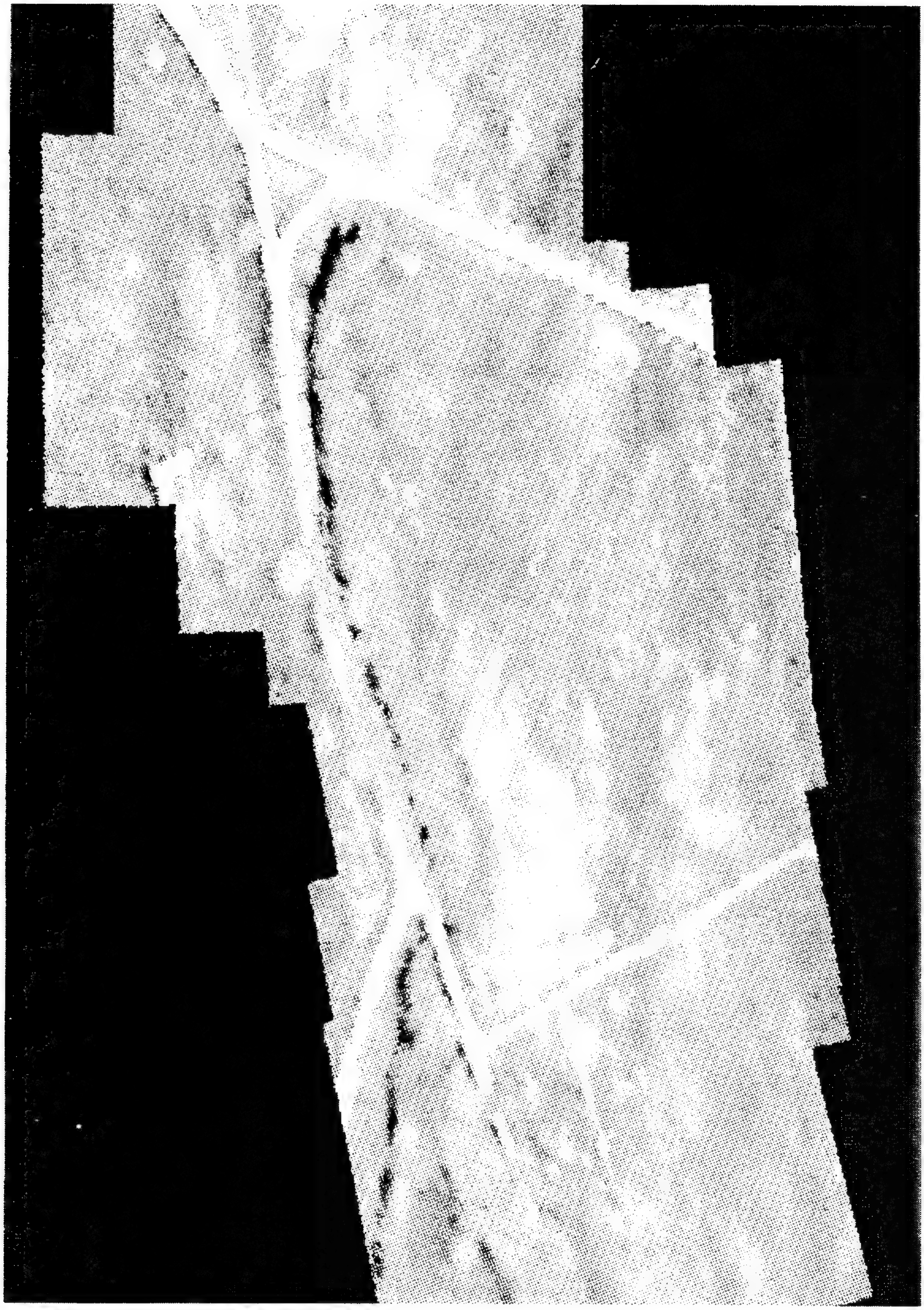

Figure A7. Inframetrics Video Mosaic at 2x.

Figure A8. Inframetrics Video Mosaic at 2x.

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Appendix B
ARTIFACT CATALOG

Catalog of Artifacts from October, 1994 Investigations.

FOR TOTALS, SUMMARY CATEGORIES:

-- "Domestic" is all ceramics, glass food storage/service artifacts; South's (1977) "Kitchen" category.

-- "Window Glass" is glass from structure windows (the 1910 Hangar).

-- "All Nails" includes all definite and possible nails, of all types, identified by the catalog.

-- "Airplane" includes only definite Wright Flyer parts.

-- "Other" is all artifacts not in the above categories.

-- "Non-artifacts" are fossils, hematite lumps, etc., not produced or deposited by human activity. "Non-artifacts" are not included in the provenience total.

Provenience: FS 1: Shovel Probe 1, at 493.85N/405.00E.

Count:	Type:	Description:
1	Airplane	Thin, flat iron (probably, steel) plate, roughly square (corroded from original shape), approx. 4.3 X 3.6 cm., with square, formed hole (fastener hole) near one edge.
1	Airplane	L-shaped, thin iron (probably, steel) plate, approx. 4.4 X 1.4 cm. along longest side, and rising to a point at approx. 1.4 cm. from the crease on the smaller side. Corroded from original dimensions.
1	Airplane	L-shaped, thin iron (probably, steel) plate, approx. 4.4 X 1.4 cm. along longest side, and rising to a point at approx. 1.6 cm. from the crease on the smaller side. Ends of longest side are beveled, possibly rounded. Both sides have bolt/fastener holes: Longest side hole is prob. square, approx. 0.6 X 0.6 cm. Hole in pointed side is round, approx. 0.6 cm. diameter. Corroded from original dimensions.

6	Misc. Iron	Flakes and chips, probably from artifacts described above.

NOTE: The three iron-plate artifacts described here resemble components of a strut support/fastener observed on the 1910-1915 Wright Flyer Model B on display at the United States Air Force Museum, Wright-Patterson Air Force Base. Assembled with the square plate on the bottom and the two L-shaped plates extending up the sides, these artifacts resemble most closely the fastener found on the base of the strut that supports the propeller shaft housings, attaching these struts to the lower wing surface.

TOTALS:

Domestic:	0
Window Glass:	0
All Nails:	0
Airplane:	3
Other:	6
Non-artifacts:	0
Provenience:	9

Provenience: FS 2: Feature 1 (post), at 483.15N/372.40E. In 2 X 2 m. Test Unit 483N/371E.

Count:	**Type:**	**Description:**
1	Bottle	Aqua glass bottle body. Probably a beverage bottle. Embossed "-EL-" in cursive script on exterior surface.
1	Window	Flat aqua glass, medium-thin, structure windows.
4	Nails	Iron, wire, post-1890 (Nelson 1968).
3	Misc. Iron	Chips and flakes, unidentified fragments.
33	Wood	Small fragments, milled lumber. Some pieces charred.

TOTALS:

Domestic:	1
Window Glass:	1
All Nails:	4
Airplane:	0
Other:	36
Non-artifacts:	0
Provenience:	42

Provenience: FS 3: Feature 2, at 483.95N/374.24E. In 2 X 2 m. Test Unit 483N/373E.

Count:	**Type:**	**Description:**
1	Bottle?	Clear glass, small curved fragment, bottle or drinking/serving vessel. No further ID possible.
3	Window	Flat aqua glass, medium-thin, structure windows.
1	Nail	Iron, wire, post-1890 (Nelson 1968). Carbonization on nail shank shows burning, possibly post-demolition burning of scrap lumber.
15	Nails	Iron, wire, post-1890 (Nelson 1968).
1	Nail	Iron, wire, short-shank roofing nail. Post-1890 (Nelson 1968).
7	Nails?	Iron wire, probably nails and nail fragments. Too corroded for more specific ID.
1	Wire	Iron, smooth-side, single-strand. Probably for fencing.
5	Misc. Iron	Chips and flakes, unidentified fragments.

2	Shell Base	Brass and paper wadding, shotgun shell base. Diagonally-slashed decorative band around base, no embossments. Firing pin in place. Probably a civilian round.
3	Roofing	Fragments of asphalt roofing shingles. Black with red flecks.
1	Roofing?	Small lump of tar or asphalt. May be from melted roofing shingles, or from roof repairs.
20	Charcoal	Small fragments, burnt wood and charcoal. May be from burned lumber.
12	Wood	Small fragments, milled lumber. All pieces charred.
1	Fossil?	Small, white piece, coral or crinoid stem. May be a fossil. Non-artifactual.

TOTALS:

Domestic:	1
Window Glass:	3
All Nails:	24
Airplane:	0
Other:	44
Non-artifacts:	1
Provenience:	72

Provenience: FS 4: 2 X 2 m. Test Unit 483N/373E. Piece-plotted artifact at point 483.32N/373.48E.

Count:	**Type:**	**Description:**
1	Hinge	Very large iron strap hinge. Long, triangle-shaped hinge; 21 cm. from butt to rounded point, and 8.0 cm. across at butt. Four fastener holes in zig-zag pattern across each strap; approx. 0.8 cm. diameter to each hole (measured at least-

		corroded hole). Fastener hole at narrow end of strap on one side has small, iron, wire nail (post-1890; Nelson 1968) concreted into hole. One attachment to pintle in center of one strap; two pintle attachments at edges of other strap. Straps are folded over atop one another and are slightly bent, probably from damage during structure demolition. Tapered end of one strap, "interior" side has traces of grey substance on surface; probably paint. This may mean that what is now "interior" surface of hinge straps was once top surface (away from wood), when attached to structure. Plain, undecorated strap hinge, usually used on barn doors, industrial buildings, or gates.
1	Nail	Iron, wire, post-1890 (Nelson 1968). Small nail, very like the one found concreted in the fastener hole at the narrow end of one of the straps of the hinge described above. Probably was associated with hinge when collected, but became separated in collection bag.
6	Misc. Iron	Chips and flakes, unidentified fragments, probably from hinge.

NOTE: The large strap hinge described here appears to be identical to hinges found on the personnel doors added to the 1910 Hangar for the 1924 Dayton Air Show, and seen in photographs of the hangar from and postdating that period. These photographs are presented in Brown (1993).

TOTALS:

Domestic:	0
Window Glass:	0
All Nails:	1
Airplane:	0
Other:	7
Non-artifacts:	0
Provenience:	8

Provenience:	FS 5: Backdirt along East Wall of Machine Trench 3.	
Count:	**Type:**	**Description:**
1	Bottle	Cobalt blue glass, bottle side, medicine bottle. Embossed "EME-/DRUG/BALTIM-". Probably is Bromo Seltzer Bottle, Emerson Drug Company, Baltimore, Maryland. Post-1889 (Fike 1987:111).
1	Bottle	Aqua glass, bottle body, no identifying marks.
3	Window	Flat, aqua glass, relatively thin. Structure window.
3	Nails	Iron, wire, post-1890 (Nelson 1968).
1	Brush	Bone, carved toothbrush handle. Handle end with pointed tip.

TOTALS:

Domestic:	2
Window Glass:	3
All Nails:	3
Airplane:	0
Other:	1
Non-artifacts:	0
Provenience:	9

Provenience:	FS 6: 2 X 2 m. Test Unit 483N/373E, Level 1, 0-20 cm. below surface.	
Count:	**Type:**	**Description:**
3	Bottle	Aqua glass, probably beverage or medicine bottle body. Largest piece has part of embossment (illegible). No further identification possible.
1	Bottle?	Clear glass, small curved fragment, bottle or drinking/serving vessel. No further identification possible.

2	Bottle?	Clear glass, small curved fragment, bottle or drinking/serving vessel. Molded band on what appears to be vessel shoulder.
24	Window	Flat aqua glass, medium-thin, structure windows.
1	Misc. Glass	Melted aqua glass. Probably window glass.
1	Spike?	Machine-cut, machine-headed, 1830-1890 (Nelson 1968). Large nail or spike; width of 0.9 cm. just below head; shank is broken. Persistence of earlier-type nail in building built in 1910 is probably due to special structural function of spike/large nail, in joining large timbers.
9	Nails	Iron, wire, post-1890 (Nelson 1968). Carbonization of nails shows burning. Carbonization is on nail heads and one nail tip, indicating post-demolition burning of scrap lumber.
71	Nails	Iron, wire, post-1890 (Nelson 1968).
2	Nail	Iron, wire, short-shank roofing nail. Completely carbonized, probably indicating post-demolition burning. Possible galvanization of nails (common to this type) may also have contributed to preservation. Post-1890 (Nelson 1968).
19	Nails	Iron, wire, short-shank roofing nails. Post-1890 (Nelson 1968).
8	Nails	Iron, wire, medium-shank roofing nails. Post-1890 (Nelson 1968).
1	Nail	Iron, wire, medium-shank roofing nail. Post-1890 (Nelson 1968). Carbonization of nail shows burning. Carbonization is on nail head, indicating post-demolition burning of scrap lumber.
49	Nails	Iron. May be square, machine-cut, machine-headed nails, or may be round, wire nails. Too corroded for specific identification.
4	Nails?	Iron wire, probably nails and nail fragments. Too corroded for more specific identification.

1	Chain	Iron, chain link, broken. "Dog" or other animal chain, round link bent into shallow U-shape. Not airplane part.
1	Fastener?	Iron, small (0.4 cm. diameter) rod, with scribing (ridges) on both sides. Probably is part of screw or threaded rod.
1	Wire	Iron, braided wire. 0.6 cm. diameter. Electrical-power supply wire, as for an engine battery. Possible airplane part; more likely, an automobile part.
2	Wire	Iron, smooth-side, single-strand. Probably for fencing.
10	Iron Sheet	Small fragments of flat iron sheet, cans or roofing. Several fragments have grey residue of paint, grease or some other substance on one surface.
22	Misc. Iron	Chips and flakes, unidentified fragments.
1	Brass Strip	Brass sheet, painted silver on one side. Probably cut from larger sheet. Approx. 9.2 X 1.2 cm. Unknown function.
1	Shell Case	Brass, .38(?) caliber long (rifle) shell casing. Probably a civilian round.
4	Shell Case	Brass, .22 caliber short (pistol?) shell casing. Probably civilian round, although may be from small military sidearm.
8	Roofing	Fragments of asphalt roofing shingles. Black with red flecks.
2	Roofing?	Fragment/nodule of tar or asphalt. May be melted pieces from roofing shingle, or burnt shingle. Small, flat pieces.
1	Slag?	Black, burnt object. Probably coal, metal or other slag.
80	Charcoal	Small fragments, burnt wood and charcoal. May be from burned lumber.
37	Wood	Small fragments, milled lumber. All pieces charred.
2	Wood	Small fragments, milled lumber. Not charred.

1	Insect	Baked mud wasp nest fragment, 10 complete or partial holes. Clay/mud matrix of nest probably burned (and fired) when scrap lumber was burned.
1	Fossil	Crinoid(?) stem cap(?) Unidentified fossil. Non-artifactual.

TOTALS:

Domestic:	6
Window Glass:	24
All Nails:	163
Airplane:	0
Other:	174
Non-artifacts:	2
Provenience:	367

Provenience: FS 7: Machine Trench 4, General Collection.

Count:	**Type:**	**Description:**
1	Bottle?	Clear glass, small curved fragment, bottle or drinking/serving vessel. No further identification possible.
2	Window	Flat aqua glass, medium-thin, structure windows.
6	Nails	Iron, wire, post-1890 (Nelson 1968).
5	Nails?	Iron wire, probably nails and nail fragments. Too corroded for more specific identification.
1	Wire	Iron, smooth-side, single-strand. Probably for fencing.
1	Wood	Large fragment, milled lumber. Piece contains large knots; tougher wood at/near knots was preserved, while remainder of timber decayed. End of wood away from knot has an

		angled saw cut. This cut describes an angle of approx. 35 degrees with the prevailing grain of the piece; this (35 degrees) was probably the original angle of the cut.
1	Wood	Large fragment, milled lumber. Piece contains large knots; tougher wood at/near knots was preserved, while remainder of timber decayed.

TOTALS:

Domestic:	1
Window Glass:	2
All Nails:	11
Airplane:	0
Other:	3
Non-artifacts:	0
Provenience:	17

Provenience: FS 8: 2 X 2 m. Unit, 483N/377E, Level 1: 0-20 cm. below surface.

Count:	**Type:**	**Description:**
1	Bottle	Manganese-tint clear glass, bottle base with one mold seam. 1880-1925 (Newman 1971).
4	Bottle	Aqua glass, small fragment, probably beverage or medicine bottle neck. No further identification possible.
7	Bottle?	Clear glass, small curved fragment, bottle or drinking/serving vessel. No further identification possible.
4	Lamp?	Very thin clear glass. Either lamp-chimney or electric light bulb.
18	Window	Flat aqua glass, medium-thin, structure windows.
1	Misc. Glass	Melted aqua glass. Probably window glass.

7	Nails	Iron, wire, post-1890 (Nelson 1968). Carbonization of nails shows burning. Carbonization is on nail heads, indicating post-demolition burning of scrap lumber.
156	Nails	Iron, wire, post-1890 (Nelson 1968).
1	Nail	Iron, wire, short-shank roofing nail. Completely carbonized, probably indicating post-demolition burning. Possible galvanization of nails (common to this type) may also have contributed to preservation. Post-1890 (Nelson 1968).
25	Nails	Iron, wire, short-shank roofing nails. Post-1890 (Nelson 1968).
13	Nails	Iron. May be square, machine-cut, machine-headed nails, or may be round, wire nails. Too corroded for specific identification.
118	Nails?	Iron wire, probably nails and nail fragments. Too corroded for more specific identification.
3	Chain	Iron, chain links. "Dog" or other animal chain, round links bent into shallow U-shape. Not airplane parts.
2	Wire	Iron, smooth-side, single-strand. Probably for fencing.
4	Misc. Iron	Chips and flakes, unidentified fragments.
1	Band	Aluminum, stamped band, approx. 0.9 cm wide, curved into ring/tube. Embossed "WP-663." Probably a recent bird-tagging band.
1	Shell Case	Brass, .44 caliber long (rifle) shell casing. Probably a military round.
5	Shell Case	Brass, .22 caliber short (pistol?) shell casing. Probably civilian round, although may be from small military sidearm.
2	Shell Base	Semi-clear polymer shotgun shell base, 2 pieces, probably from same shell. Very recent. Largest piece embossed "RBM-PET/PATENTED" in center of base. Probably a civilian round.

34	Roofing	Fragments of asphalt roofing shingles. Black with red flecks.
1	Roofing	Fragments of asphalt roofing shingles. Black with red flecks. Multiple pieces fused together, probably by post-demolition burning.
1	Roofing?	Fragment/nodule of tar or asphalt. May be melted piece from roofing shingle, or burnt shingle. Small, flat piece.
10	Charcoal	Small fragments, burnt wood and charcoal. May be from burned lumber.
34	Wood	Small fragments, milled lumber. Some pieces slightly charred.
1	Bone	Bird bone-femur? Probably chicken.

TOTALS:

Domestic:	16
Window Glass:	18
All Nails:	320
Airplane:	0
Other:	99
Non-artifacts:	1
Provenience:	453

Provenience: FS 9: 2 X 2 m. Unit 501N/377E, Level 1: 0-10 cm. below surface.

Count:	**Type:**	**Description:**
1	Ceramic	Small body sherd, unknown vessel. Plain porcelain, c. 1900.

1	Jar?	Very thick clear glass base. Molded. Probably large jar. May be some sort of lens, or large vessel base.
1	Bottle	Aqua glass, body, no marks.
2	Bottle?	Clear glass, body, small, no marks. Bottle or vessel.
6	Window	Flat aqua glass, medium-thin.
2	Nails	Iron, wire, post-1890 (Nelson 1968). Carbonization of nails shows burning.
40	Nails	Iron, wire, post-1890 (Nelson 1968).
3	Nails	Iron, wire, short-shank roofing nails. Completely or partially-carbonized, probably indicating post-demolition burning. Possible galvanization of nails (common to this type) may also have contributed to preservation. Post-1890 (Nelson 1968).
10	Nails	Iron, wire, short-shank roofing nails. Post-1890 (Nelson 1968).
1	Nail	Iron, wire, medium-shank roofing nails. Post-1890 (Nelson 1968).
1	Nail?	Iron wire, probably a nail. Too corroded for more specific identification.
1	Fastener	Iron shank with scribing on one side. Probably screw; scribing is screw threads.
1	Chain	Iron, chain link. "Dog" or other animal chain, round link bent into shallow U-shape. NOT airplane part.
2	Wire	Iron, smooth-side, single-strand. Probably for fencing.
2	Misc. Iron	Chips and flakes, unidentified fragments.
1	Shell Case	Brass, .22 caliber long (rifle) shell casing. Probably civilian round, although may be from small military sidearm. Fired.
2	Shell Case	Brass, steel and plastic shotgun-shell cases. Probably civilian. Fired.

4	Roofing	Fragments of asphalt roofing shingles. Black with red flecks.
6	Charcoal	Small fragments, charcoal. May be from burned lumber.
1	Wood	Small fragment, milled lumber.
4	Coal	Small pieces. Fuel.
11	Slag	Small pieces. Probably iron slag, from casting or forging.
1	Unknown	Small piece of stone(?). May be a fossil.
595	Hematite	Naturally-occurring iron nodules; non-artifactual.

TOTALS:

Domestic:	5
Window Glass:	6
All Nails:	57
Airplane:	0
Other:	35
Non-artifacts:	596
Provenience:	103

Provenience: FS 10: 2 X 2 m. Unit 483N/381E, Level 1, 0-20 cm. below surface (natural level).

Count:	**Type:**	**Description:**
1	Bottle	Aqua glass, body, no marks.
1	Bottle	Clear glass, bottle base, cup-bottom mold (post-1845; Jones and Sullivan 1985). Very small fragment.
6	Bottle?	Clear glass, body, small, no marks. Bottle or vessel.

1	Bottle?	Manganese-tint clear glass, body, small, no marks. Bottle or vessel. 1880-1925 (Newman 1971).
2	Lamp?	Very thin clear glass. Either lamp-chimney or electric light bulb.
19	Window	Flat aqua glass, medium-thin.
1	Nail	Iron, wire, post-1890 (Nelson 1968). Carbonization of nail shows burning. Carbonization is on nail head, indicating post-demolition burning of scrap lumber.
89	Nails	Iron, wire, post-1890 (Nelson 1968).
31	Nails	Iron, wire, short-shank roofing nails. Post-1890 (Nelson 1968).
1	Nail	Iron, wire, possible short-shank nail (or, broken shank). Post 1890 (Nelson 1968). Attached washer (concreted to nail). Probably used in roofing.
89	Nails?	Iron wire, probably nails. Too corroded for more specific identification.
1	Fastener?	Iron shank with right-angle bend at one end. May be a clinched nail, but is more probably part of a staple.
1	Chain	Iron, chain link. "Dog" or other animal chain, round link bent into shallow U-shape. Not airplane part.
6	Wire	Iron, smooth-side, single-strand. Probably for fencing.
1	Wire	Iron, barbed fence wire. Large barbs; possibly military.
1	Unknown	Iron, Y-shaped wire artifact. Unknown function.
164	Misc. Iron	Chips and flakes, unidentified fragments.
2	Shell Cases	Brass, .22 caliber short (pistol) shell casing. Probably civilian round, although may be from small military sidearm. Fired. One casing crushed after being fired.

1	Shell Case	Brass & plastic shotgun-shell case. Embossed "W-W/12 GAUGE" around firing-pin hole on base. Probably civilian. Fired.
1	Shell Case	Brass shotgun-shell case base. Basal embossment illegible. Probably civilian.
1	Shell Case	Brass firing pin assembly, including fragments of paper wadding. From shotgun-shell case base.
1	Skeet	Clay/graphite skeet target fragment, w/ remnant of fluorescent-orange paint on one side. Very small fragment. From Base Recreation Skeet Range, southeast of site.
2	Brass Sheet	Small (1.5 cm. across base) triangular pieces of thin brass sheet. Half-round holes punched into base of triangle, possibly through original square piece. May be fragments of fastening tab from larger brass object.
1	Screw	Small (0.9 cm. head diameter), short-shank (0.6 cm. shank length) brass machine screw. May be associated with brass sheet fastener, above.
386	Roofing	Fragments of asphalt roofing shingles. Black with red flecks. Very small fragments, usually less than 1.0 cm in diameter.
3	Roofing	Fragments of asphalt roofing shingles. Black with red flecks. Multiple pieces fused together, probably by post-demolition burning of debris.
57	Roofing?	Fragments/nodules of tar or asphalt. May be melted pieces from roofing shingles, or tar nodules left over from roof repairs.
68	Charcoal	Small fragments, charcoal. May be from burned lumber.
127	Wood	Small fragments, probably milled lumber. Some pieces are slightly charred.
3	Coal	1 medium-sized piece. Fuel.

8	Slag	Small pieces. Probably iron slag, from casting or forging. Some may be coal clinker (cinders), from burning coal as fuel.
2	Coral	Pieces of marine coral, one small, one medium-sized. Both burnt. May have been used as pumice stones (abrasives).
1	Bone	End of fractured bird bone-femur? Probably chicken.

TOTALS:

Domestic:	11
Window Glass:	19
All Nails:	211
Airplane:	0
Other:	842
Non-artifacts:	3
Provenience:	1083

Provenience: FS 11: 2 X 2 m. Unit 501N/377E, Level 2, 10-20 cm. below surface.

Count:	**Type:**	**Description:**
1	Airplane	Iron, drive-chain side plate. Approx. 3.4 cm. long (one end broken to bolt hole) by 1.0 cm. wide at center of plate. Slightly larger (up to 1.3 cm. wide) on rounded end around bolt holes. Bolt holes (intact one measured) have 0.7 cm. diameter. Fairly thin; approx. 0.1-0.2 cm. thick. All dimensions approximate, due to corrosion.
2	Ceramic	Small body sherd, unknown vessel. Plain porcelain, c. 1900.
1	Bottle	Aqua glass, body, no marks.

2	Bottle?	Manganese-tint clear glass, body, small, no marks. Bottle or vessel. 1880-1925 (Newman 1971).
9	Window	Flat aqua glass, medium-thin.
1	Spike	Machine-cut, machine-headed, 1830-1890 (Nelson 1968). Very large nail or spike; width of 1.1 cm. just below head; shank is broken. Persistence of earlier-type nail in building built in 1910 is probably due to special structural function of spike, in joining large timbers.
49	Nails	Iron, wire, post-1890 (Nelson 1968).
2	Nails	Iron, wire, short-shank roofing nails. Completely or partially-carbonized, probably indicating post- demolition burning. Possible galvanization of nails (common to this type) may also have contributed to preservation. Post-1890 (Nelson 1968).
19	Nails	Iron, wire, short-shank roofing nails. Post-1890 (Nelson 1968).
14	Nails?	Iron wire, probably nails. Too corroded for more specific ID.
1	Chain	Iron, chain link. "Dog" or other animal chain, round link bent into shallow U-shape. Not airplane part.
6	Wire	Iron, smooth-side, single-strand. Probably for fencing.
1	Fitting	Cast iron pipe with U-shaped projections at one end, and flat piece cast onto one side. Unknown function.
1	Unknown	Piece of iron wire, with iron rings or chain links draped along it. Wire and rings/chain are concreted together. Possibly a piece of barbed wire ("chain links" are base for barbs, wrapped around straight shaft).
8	Misc. Iron	Chips and flakes, unidentified fragments.
1	Roofing	Fragments of asphalt roofing shingles. Black with red flecks.
3	Charcoal	Small fragments, charcoal. May be from burned lumber.

16	Coal	Small pieces. Fuel.
17	Slag	Small pieces. Probably iron slag, from casting or forging.
1	Bone	Small fragment of animal bone, possibly bird. No species ID possible.
1	Unknown	Small piece of mollusk shell(?).
1769	Hematite	Naturally-occurring iron nodules; non-artifactual.

TOTALS:

Domestic:	5
Window Glass:	9
All Nails:	85
Airplane:	1
Other:	54
Non-artifacts:	1771
Provenience:	154

Provenience: FS 12: 2 X 2 m. Unit, 483N/377E, 20 cm. below surface, artifact piece-plotted in plan view.

Count:	**Type:**	**Description:**
1	Washer	Large iron washer, diameter of 6.4 cm, interior hole diameter of 2.5 cm, thickness of approx. 0.4 cm. Probably somewhat corroded from original dimensions. Structural artifact.

TOTALS:

Domestic:	0
Window Glass:	0

All Nails:	0
Airplane:	0
Other:	1
Non-artifacts:	0
Provenience:	1

Provenience: FS 13: 2 X 2 m. Unit 483N/377E, at planned surface, 20 cm. below surface. Piece-plotted artifact from plan view.

Count:	**Type:**	**Description:**
1	Bolt	Very large (1.5 cm. diameter; 28.5 cm. length) iron (steel) bolt/nut assembly, with 3 attached washers. Bolt is large carriage bolt; 2.7 cm. diameter round head, short (1.2 cm.) square shank, with much longer (23.5 cm.) round, blind shank and short (c. 3 cm.) threaded end. Nut is square; 2.5 X 2.5 cm., frozen at top of threaded shank to bolt. Washer is 3.3 cm. diameter, frozen to blind shank (may be welded there) approx. 9.0 cm. down from bolt head. Two larger washers (6.0 cm. diameter, top, and 8.0 cm. diameter, bottom) are free between frozen, smaller washer and head of bolt. These washers are cast steel, with a three-pronged design on the exterior of the top washer, and a four-pronged design on the exterior of the bottom washer. Interior surfaces of both washers have hollows matching the exterior designs. The larger bottom washer has two small (0.8 cm.) triangular projections from its circumference, separated from each other by approx. 1/4 of the washer circumference. The smaller top washer has two notches in its circumference, equidistant from each other. Traces of grey paint, grease or some other substance are found on the bolt head and both of the free washers. This artifact may be part of the roller assembly for the 1910 Hangar doors, or it may be a structural bolt assembly, for tying together very large, structural timbers or major building subassemblies.

TOTALS:

Domestic:	0
Window Glass:	0
All Nails:	0
Airplane:	0
Other:	1
Non-artifacts:	0
Provenience:	1

Provenience: FS 14: 2 X 2 m. Test Unit 483N/377E, at planned surface, 20 cm. below surface. Piece-plotted artifact from plan view.

Count:	**Type:**	**Description:**
1	Weight	Large, heavy iron weight; may have lead core (no filling ports for such core visible on object surface). Estimated weight of 5 pounds/2.27 kg. Length 11.5 cm., maximum diameter of 2.8 cm, tapering to diameter of 1.3 cm. at rounded ends. Torpedo-shaped weight, characteristic of window sash weights, or weights for large, heavy draperies. May be from 1924 Dayton Air Show use of Hangar; could be a drapery weight from this time (e.g. from a canvas tarp, or a hanging cloth sign or screen). May also be an airplane part, a free weight applied to balance aircraft in some manner.

TOTALS:

Domestic:	0
Window Glass:	0
All Nails:	0
Airplane:	(?)

Other: 1

Non-artifacts: 0

Provenience: 1

Provenience: FS 15: 2 X 2 m. Test Unit 483N/377E, Level 2, 20-30 cm. below surface, west half of unit (1 X 2 m. area).

Count:	**Type:**	**Description:**
1	Window	Flat aqua glass, medium-thin.
7	Nails	Iron, wire, post-1890 (Nelson 1968).
2	Nails	Iron, wire, short-shank roofing nails. Post-1890 (Nelson 1968).
6	Nails?	Iron wire, probably nails. Too corroded for more specific ID.
1	Roofing?	Fragment/nodule of tar or asphalt. May be melted piece from roofing shingle, or burnt shingle. Small, flat piece.
75	Wood	Small fragments, probably milled lumber. Some pieces are slightly charred.

TOTALS:

Domestic: 0

Window Glass: 1

All Nails: 15

Airplane: 0

Other: 76

Non-artifacts: 0

Provenience: 92

Provenience: FS 16: Feature 4 (in northwest corner of 2 X 2 m. Test Unit 483N/377E), fill within feature limits, 20-30 cm. below surface.

Count:	Type:	Description:
2	Window	Flat aqua glass, medium-thin.
1	Nail	Iron, wire, post-1890 (Nelson 1968).
4	Nails?	Iron wire, probably nails. Too corroded for more specific ID.
6	Misc. Iron	Chips and flakes, unidentified fragments.
1	Roofing	Fragment of asphalt roofing shingle. Black with red flecks.
70	Roofing?	Fragments/nodules of tar or asphalt. May be melted pieces from roofing shingles, or burnt shingles. Small, flat pieces.
8	Charcoal	Small fragments, charcoal. May be from burned lumber.
62	Wood	Small fragments, probably milled lumber.

TOTALS:

Domestic:	0
Window Glass:	2
All Nails:	5
Airplane:	0
Other:	141
Non-artifacts:	0
Provenience:	148

Provenience: FS 17: 2 X 2 m. Unit, 501N/377E, Level 3: 20-30 cm. below surface, in 0.5 X 2 m. trench along north wall of unit.

Count:	Type:	Description:
1	Nail	Iron, wire, short-shank roofing nail. Post-1890 (Nelson 1968).
12	Misc. Iron	Small, thin flat pieces of iron. may be shards of iron cans or roofing, or may be hematite, and non-artifactual.
104	Hematite	Naturally-occurring iron nodules; non-artifactual.

TOTALS:

Domestic:	0
Window Glass:	0
All Nails:	1
Airplane:	0
Other:	12
Non-artifacts:	104
Provenience:	13

Provenience: FS 18: 2 X 2 m. Unit, 483N/373E, West side wall. Piece-plotted artifact from profile drawing.

Count:	Type:	Description:
1	Bolt	Large iron (steel) carriage bolt. Length is 25 cm.; diameter is 1.3 cm. Round head (3.0 cm. diameter) bolt head, c. 19 cm.-long round, blind shank and 3.8 cm. threaded end. Threaded end is intentionally and regularly-bent, at approx. 17 cm. from bolt head; probably clinched in use in building construction. Bolt is probably part of major wall structure, to tie large timbers together, or part of structure for rolling hangar doors. Probably had functional association with the bolt/washers/nut assembly described as FS 13.

TOTALS:

Domestic:	0
Window Glass:	0
All Nails:	0
Airplane:	0
Other:	1
Non-artifacts:	0
Provenience:	1

Provenience: FS 19: Machine Trench 3, General Collection.

Count:	**Type:**	**Description:**
1	Window	Flat aqua glass, medium-thin.
1	Nail	Iron, wire, post-1890 (Nelson 1968). Completely carbonized, probably indicating post-demolition burning.

TOTALS:

Domestic:	0
Window Glass:	1
All Nails:	1
Airplane:	0
Other:	0
Non-artifacts:	0
Provenience:	2

Provenience: FS 20: Shovel Probe 4, at 502N/385E.

Count:	**Type:**	**Description:**
1	Window	Flat aqua glass, medium-thin.
1	Wire	Iron, smooth-side, single-strand. Probably for fencing.
1	Misc. Iron	Small chip; unidentified fragment.
2	Hematite	Naturally-occurring iron nodules; non-artifactual.

TOTALS:

Domestic:	0
Window Glass:	1
All Nails:	0
Airplane:	0
Other:	2
Non-artifacts:	2
Provenience:	3

Provenience: FS 21: Probe 5 at 502N/370E, 11-21 cm. below surface.

Count:	**Type:**	**Description:**
1	Nail	Iron, wire, post-1890 (Nelson 1968).
1	Wire	Iron, fragment, possible nail tip.

TOTALS:

Domestic:	0
Window Glass:	0
All Nails:	1
Airplane:	0

Other:	1	
Non-artifacts:	0	
Provenience:	2	
Provenience:	FS 22: Probe 7 at 490N/385E, 23-30 cm. below surface.	
Count:	**Type:**	**Description:**
1	Nail?	Iron wire, probably a nail. Too corroded for more specific ID.
1	Wood	Small fragment, milled lumber.
2	Wood	Small fragments. Probably fragments of weeds, cane, etc. Non-artifactual.

TOTALS:

Domestic:	0
Window Glass:	0
All Nails:	1
Airplane:	0
Other:	3
Non-artifacts:	0
Provenience:	4

OVER-ALL COLLECTION TOTAL:

Domestic:	48
Window Glass:	90
All Nails:	903
Airplane:	4

Other:	1540
1994 Collection:	2585
Non-artifacts:	2480
Total Number of Objects:	5065

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